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The banking and distribution sectors in a small open economy DSGE Model

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Abstract

The recent crisis has emphasized the role of financial - macroeconomic interactions, and international trade in goods and services, in the transmission of the shocks. Both phenomena, closely related to the higher degree of globalization, are very relevant for small open economies, and particularly so when a large share of the economy relies on financial and distribution services. Hence, in this paper we propose to incorporate the banking and distribution sectors into a medium scale DSGE model of a small open economy. As an illustration, the resulting model is then calibrated to match the specific characteristics of the Luxembourg economy, where the financial sector plays a key role. We believe that the results are also of more general interest for studying the reaction of small open economies to real and financial shocks.

JEL Codes: E13; E32;

Keywords: DSGE model, Small open economy, Banking, International trade, Luxembourg, Segmented labor market; Trade union

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1 Introduction

The recent crisis has emphasized the role of financial - macroeconomic interactions, and international trade in goods and services, in the transmission of the shocks. Both phenomena, closely related to the higher degree of globalization, are very relevant for small open economies, and particularly so when a large share of the economy relies on financial and distribution services. Hence, in this paper we propose to incorporate the banking and trade sectors into a medium scale Dynamic Stochastic General Equilibrium (DSGE) model of a small open economy. The resulting model is then calibrated and used to assess the consequences of a series of policies and shocks related to the financial sector, obtaing results that we believe are of general interest for studying the reaction of small open economies to such events.

The starting point is a DSGE model developed in Deak, Fontagne, Maffezzoli and Marcellino (2011) in which we introduce a distribution sector, and a financial sector comprising two tiers: domestic and international. This requires to properly modify all the other sectors of the original model.

There are five types of agents in the model: Households, Government, Firms, Banks and Unions. Households have finite lives, with a set of overlapping generations with different features in each time period, and each household maximizes an intertemporal utility function subject to a budget constraint, determining the optimal amount of consumption and financial assets. The individual households' decisions are then aggregated to determine aggregate quantities.

The Government collects taxes on the returns from assets and on labour income. The tax receipts are used to finance expenditures, which are made up of unemployment benefits, other transfers to resident and non-resident population, and public investment. When the receipts are less (more) than the expenditures there is a deficit (surplus), whose evolution over time, combined with that of interest rates, determines the level of the public debt, which is financed with the emission of government bonds.

The interest rate is taken as exogenous, in line with the small open economy assumption. However, following Schmitt-Grohé and Uribe (2004), we assume the existence of a debt-elastic interest-rate premium, i.e. an interest rate that is increasing in the country's net foreign debt.

Assets are made up of government bonds, foreign assets and claims to physical capital. These three types of assets are perfect substitutes in the household's portfolio, and earn in equilibrium the same (exogenous) real rate of return. Investment in physical capital is determined by maximizing the cash flow from investing in physical capital, conditional on the law of motion of physical capital. Households are also in charge of investment, and therefore they supply capital (and labour).

Firms produce intermediate and final goods. In the (differentiated) intermediate goods sector firms operate under monopolistic competition, using a Nested CES production function with capital and two different types of labour as inputs. The different types of labour are introduced to mimic the dual labour market present in several small open economies, and represent resident and non-resident workers. Indeed the hyper-specialization on the exporting sector (the financial cluster in our case) must rely on specialized working force from abroad. The firms choose the optimal demand of capital and of each type of labour by maximizing profits, subject to the production function constraint, taking wages and the cost of capital as given. The cost of capital is determined endogenously in order to match the demand and supply of capital. In

the final goods sector, firms operate under perfect competition, using a Nested CES production function with intermediate goods only as inputs, possibly with increasing returns to variety. Public investment increases productivity, in addition to exogenous technical progress.

The wages are determined by the interaction between the firms and the unions that represent the workers (the so-called "right to manage" model). Given the resulting wages, labour demand is determined, and it is assumed that for the current wages the supply of each type of labour adjusts to meet demand.

We introduce two banking sectors, one with domestic banks and one with international banks. In the domestic banking sector there exists a representative, competitive bank that intermediates loans between households and firms, producing financial services using capital, labor and reserves. The bank is owned by the domestic households. As in Christiano and Eichenbaum (1995) and Christiano, Motto, and Rostagno (2008), firms (and banks themselves) will need to finance a given fraction of their factor expenditure in advance, before revenues from sales can be cashed in, i.e. firms will need short-term working capital.

In the international banking sector, there exists a representative, competitive bank that intermediates loans between foreign households and foreign firms, producing financial services using capital, labor and reserves. The bank is owned by the local households. To finance the foreign demand for loans, the bank issues demand deposit liabilities to foreign households. We assume that the supply of foreign demand deposits is exogenous, and depends positively on the interest rate paid by the international bank.

We also introduce the distribution sector, where importers buy foreign varieties at a give exogenous price (including tariffs). Foreign varieties are combined with physical capital and labor to produce distribution services, which are then sold to domestic final producers and/or re-exported. Foreign demand for re-exported goods will be modeled as exogenous, in line with the usual small open economy assumption.

Due to the complexity of the model, it cannot be estimated properly and is therefore fully calibrated. As an illustration, we choose to calibrate it to match the key characteristics of the Luxembourg economy, which is one of the best examples of a small open economy specialized in the financial sector.

Finally, the calibrated model is used to assess the effects of a set of policy and shocks related to the financial sector.

Many papers have studied the role of financial-macroeconomic interactions in dynamic general equilibrium models within a closed economy framework (see Christiano, Motto, and Rostagno 2010, Gerali, Neri, Sessa and Signoretti 2010, Hilberg and Hollmayr 2011, In't Veld, Roeger, Raciborski and Ratto 2011, Paries, Sorensen and Rodriguez-Palenzuela 2010 among others). The papers by Fujiwara and Teranishi (2010) and Christiano, Trabandt and Walentin (2007) are examples of modelling financial-macroeconomic interactions in an open economy setting.

Fujiwara and Teranishi (2010) incorporate staggered loan contracts into a two country open economy model to study the dynamics of real excahnge rates. Banks in their model correspond to the domestic banking sector in our model. They collect deposits from households and provide loans to firms to finance their factor expenditure in advance. However, there are two types of banks in each country: local banks intermediate between domestic housholds and domestic firms while international banks intermediate between domestic housholds and foreign firms. Furthermore, banks in their model are monopolistically competitive, provide differentiated loans and set their interest rates according to their individual loan demand curve.

Christiano, Trabandt and Walentin (2007) construct and estimate several versions of a small open economy DSGE model with financial and employment frictions to study business cycle dynamics in the Swedish economy. Their benchmark New Keynesian model features Calvo wage setting and no banking sector; the households allocate their savings between foreign and domestic bonds and the latter are used to finance the working capital requirements of firms without explicitely modelling financial intermedition.

The paper is structured as follows. In Section 2 we describe the model, with some more details in the Appendix. In Section 3 we discuss the calibration and steady state. In Section 4 we conduct a set of experiments related to the banking sector. In Section 5 we summarize the main results and conclude.

2 The structure of the model

In this section we provide a detailed description of the main components of the model. Specifically, we discuss, in turn, households, financial assets, firms and unions, the domestic and international banks, and the government. The inclusion of the banking and distribution sectors is our main original theoretical contribution. It requires to also modify the derivations for the households, financial assets, firms, unions and the government with respect to those in Deak et al. (2011).

2.1 Households

2.1.1 The household's problem at the cohort level

Following Blanchard (1985), in period t, the representative consumer of generation z maximizes her expected lifetime utility:

$$\mathrm{u}_{z,t} = \sum_{s=t}^{\infty} (\varphi\beta)^{s-t} u\left(x_{z,s}\right) \tag{1}$$

where $\varphi \in (0,1)$ represents the constant *probability of survival*, i.e. the share of individuals that survive in each period, β the subjective discount factor, $x_{z,t} \equiv \{c_{z,t}, d_{z,t}, m_{z,t}/p_t\}$ with c_t denoting non-durable consumption (from now on, consumption *tout court*), d_t the end-of-period desired stock of durable consumption goods (from now on, durables), $m_{z,t}$ the real money holdings kept for transaction purposes, and p_t the price of non-durable consumption. The utility function, $u\left(x_{z,t}\right)$, is of the constant relative risk aversion (CRRA) type:

$$u\left(x_{z,t}\right) \equiv \frac{\left\{\left[\phi_C c_{z,t}^{\upsilon} + \phi_D d_{z,t}^{\upsilon} + \phi_M \left(\frac{m_{z,t}}{p_t}\right)^{\upsilon}\right]^{\frac{1}{\upsilon}}\right\}^{1-\sigma} - 1}{1-\sigma}. \tag{2}$$

where $\phi_C + \phi_D + \phi_M = 1$, and $\phi_M = 0$ in Deak et al. (2011).

There is a fixed individual endowment of money, $\bar{m}$, that can be used as cash for transaction purposes, or invested into demand deposits. Demand deposits are liquidated before the end of the period, and pay an interest rate i_t^D. Hence, the period-by-period budget constraint for the representative agent in generation z

can be written as:

$$a_{z,t} = \frac{R_t}{\varphi} a_{z,t-1} + (1-\tau_K)\, i_t^D\, (\bar{m} - m_{z,t}) + \omega_t + \\ - (1+\tau_C)\, p_t \left[c_{z,t} + \varkappa_t^d \left(d_{z,t} - \frac{1-\delta_D}{\varphi} d_{z,t-1} \right) \right], \quad (3)$$

where:

$$R_t \equiv 1 + (1-\tau_K)\, i_t. \quad (4)$$

The variables are defined as follows: a_t is the end-of-period asset stock, R_t is gross rate of return common across assets, τ_K is the tax rate on financial asset returns, i_t the *exogenous* (small open economy assumption) interest rate, i_t^D the endogenous interest rate on demand deposits, ω_t is current non-financial income, p_t is the price of the final good, τ_C is the tax rate on consumption, δ^D is the depreciation rate of durables, and $\varkappa_t^d$ is an exogenous shock to the relative price for durables. Note that we are assuming that the final consumption good can be transformed into durables at a rate $\varkappa_t^d$. Furthermore, note that $a_{t,t-1} = 0$, for $t \geq z$, meaning that new generations have no endowments.

Following Schmitt-Grohe and Uribe (2004), we assume the existence of a debt-elastic interest-rate premium, i.e. an interest rate that is increasing in the country's net foreign debt:

$$i_t = \bar{\imath} + \xi_i \left[\exp\left(\bar{F} - \frac{F_t}{GDP_t} \right) - 1 \right] + \varepsilon_{it} \quad (5)$$

where F_t represents the country's net foreign asset position, $\bar{\imath}$ the long-run, constant, and exogenous interest rate if the country runs its steady-state net foreign asset position ($\bar{F}$), and ε_{it} an interest-rate shock.

Current non-financial income is defined as:

$$\omega_t \equiv (1-\tau_L)\left[w_{1,t} h_{1,t} + \bar{w}_{1,t} (1 - h_{1,t}) \right] + (1-\tau_K)\, \pi_t + tr_t, \quad (6)$$

where $h_{1,t}$ is the employment rate of resident workers (at the individual level, the unemployment rate can be interpreted as the probability of being unemployed), $w_{1,t}$ their wage rate[1], τ_L the tax rate on labour related income, $\bar{w}_{1,t}$ the unemployment benefits for resident former workers, π_t the exogenous, individual share of total firm profits, and tr_t the net government transfer. Note that the expression for labour income reflects the assumption of perfect unemployment insurance, and the existence of two types of labour, resident and non-resident. This dual labour market is present in several small open economies.

The households maximize the objective function (**??**) subject to (**??**) and a standard no-Ponzi game condition. The resulting first-order conditions can be combined into two Euler equations:

$$u_c\,(x_{z,t+1})\, \beta R_{t+1} \frac{p_t}{p_{t+1}} = u_c\,(x_{z,t}), \quad (7)$$

$$u_d\,(x_{z,t}) + \beta\,(1-\delta_D)\, \varkappa_{t+1}^d u_c\,(x_{z,t+1}) = \varkappa_t^d u_c\,(x_{z,t}), \quad (8)$$

and an intratemporal condition:

$$u_m\,(x_{z,t}) = u_c\,(x_{z,t})\, \frac{(1-\tau_K)\, i_t^D}{(1+\tau_C)\, p_t}. \quad (9)$$

[1] More precisely, for the sake of notational simplicity, w_{1t} is the weighted averare of sectoral wages, weighted with the corresponding employment shares (see eq. **??**, p. **??**).

After some manipulations, we can show that:

$$m_{z,t} = \iota_t c_{z,t}, \tag{10}$$

$$d_{z,t} = \xi_t c_{z,t}, \tag{11}$$

where:

$$\iota_t \equiv \left(\frac{\phi_C}{\phi_M}\frac{1-\tau_K}{1+\tau_C} i_t^D\right)^{\frac{1}{\upsilon-1}} p_t, \tag{12}$$

$$\xi_t \equiv \left\{\frac{\phi_C}{\phi_D}\left[\varkappa_t^d - \varkappa_{t+1}^d \frac{1-\delta_D}{R_{t+1}\frac{p_t}{p_{t+1}}}\right]\right\}^{\frac{1}{\upsilon-1}}. \tag{13}$$

Furthermore, we can show that:

$$c_{z,t} = \zeta_t^{-1}\left(\frac{R_t}{\varphi} a_{z,t-1} + h_t^w\right), \tag{14}$$

$$\zeta_t = \mathcal{Z}_t + \mathcal{E}_{t+1}\frac{\varphi}{R_{t+1}}\zeta_{t+1}, \tag{15}$$

where:

$$h_t^w \equiv \sum_{s=t}^{\infty} \mathrm{R}_{t,s}\left[(1-\tau_K)\, i_s^D \bar{m} + \omega_s\right], \tag{16}$$

represents human wealth plus the current value of the individual money stock, and:

$$\mathcal{E}_{t+1} \equiv \left\{\left[\frac{\phi_C + \phi_D \xi_{t+1}^{\upsilon} + \phi_M \iota_{t+1}^{\upsilon}}{\phi_C + \phi_D \xi_t^{\upsilon} + \phi_M \iota_t^{\upsilon}}\right]^{\frac{1-\upsilon-\sigma}{\upsilon}} \beta R_{t+1}\frac{p_t}{p_{t+1}}\right\}^{\frac{1}{\sigma}}, \tag{17}$$

$$\mathcal{Z}_t \equiv (1+\tau_C)\, p_t\left[1 + \varkappa_t^d\left(\xi_t - \frac{1-\delta_D}{\varphi}\frac{\xi_{t-1}}{\mathcal{E}_t}\right)\right] + (1-\tau_K)\, i_t^D \iota_t. \tag{18}$$

2.1.2 Aggregation

Let us assume that the size of each new-born generation is z_t, where $z_t = \eta^t z_{-\infty}$ and $z_{-\infty}$ is normalized to one. Then, the total population at any date t, Z_t, is equal to $z_t/\left(1-\frac{\varphi}{\eta}\right)$, and $Z_{t+1} = \eta Z_t$. The expressions for the aggregate variables can be obtained by linear aggregation of those at the cohort level. Aggregating the budget constraint over cohorts, we obtain an equation describing the evolution of aggregate assets:

$$A_t \equiv \sum_{j=0}^{\infty} \varphi^j z_{t-j} a_{z_{t-j},t} = R_t A_{t-1} + \mathcal{H}_t - \mathcal{Z}_t C_t, \tag{19}$$

where

$$\mathcal{H}_t \equiv \left[(1-\tau_K)\, i_t^D \bar{m} + \omega_t\right] Z_t, \tag{20}$$

and $\mathcal{Z}_t C_t$ represents the total aggregate value of current consumption and net investment in durables. Next, let us consider aggregate net human wealth, $H_t^w \equiv \sum_{j=0}^{\infty} \varphi^j z_{t-j} h_t^w = h_t^w Z_t$. The evolution of aggregate net human wealth is given by:

$$H_{t+1}^w = \frac{\eta}{\varphi} R_{t+1}\left(H_t^w - \mathcal{H}_t\right). \tag{21}$$

For aggregate consumption, aggregating equation (**??**) over cohorts yields:

$$C_t \equiv \sum_{j=0}^{\infty} \varphi^j z_{t-j} c_{z_{t-j},t} = \zeta_t^{-1}\left(R_t A_{t-1} + H_t^w\right), \tag{22}$$

The evolution of aggregate consumption is governed by the aggregate Euler equation:

$$C_{t+1} = \eta \mathcal{E}_{t+1} \left(C_t - \frac{\eta - \varphi}{\eta} \frac{A_t}{\zeta_t - \mathcal{Z}_t} \right). \tag{23}$$

Finally, for aggregate durables and cash holdings we have:

$$D_t \equiv \sum_{j=0}^{\infty} \varphi^j z_{t-j} d_{z_{t-j},t} = \xi_t C_t, \tag{24}$$

$$M_t \equiv \sum_{j=0}^{\infty} \varphi^j z_{t-j} m_{z_{t-j},t} = \iota_t C_t. \tag{25}$$

2.2 Aggregate asset stock

Financial wealth can be held as government bonds, foreign bonds, and claims to physical capital. Hence,

$$A_t = B_t + F_t + V_t, \tag{26}$$

where B_t represents the value of the end-of-period stock of government bonds, F_t the value of the end-of-period stock of foreign assets, and V_t the value of the end-of-period stock of claims to physical capital, all measured in consumption units. By assuming assets to be perfect substitutes in the household's portfolio, they earn the same (exogenous) real rate of return in equilibrium. We will now analyze in detail the different types of assets.

We are particularly interested in the cash flow from physical capital since, as mentioned, we assume that households as a whole, which can be considered as an investment firm, are also in charge of investment. More specifically, investment is determined by maximizing the cash flow from investing in physical capital, conditional on the law of motion of physical capital.

The cash flow from investing in physical capital is given by:

$$\sum_{s=t}^{\infty} \tilde{\mathrm{R}}_{t,s} \left\{ \left[(1 - \tau_K) \frac{r_s}{p_s} + \tau_K \delta_K \right] K_{s-1} - I_s \right\}, \tag{27}$$

where $\tilde{\mathrm{R}}_{t,s} \equiv \prod_{j=t+1}^{s} \left[R_j \left(p_{j-1}/p_j \right) \right]^{-1}$ is the aggregate discount factor,[2] r_t is the rental rate on capital, and I_t denotes investment. Note that the investment firm can deduct all depreciation from its taxable income. Physical capital evolves according to:

$$K_t = (1 - \delta_K) K_{t-1} + \Xi \left(\frac{I_t}{K_{t-1}} \right) K_{t-1}, \tag{28}$$

where δ_K is the depreciation rate of capital and the term $\Xi \left(\frac{I_t}{K_{t-1}} \right) K_{t-1}$ indicates that there are adjustment costs. In particular, following Jermann (1998), we assume that those are

$$\Xi \left(\frac{I_t}{K_{t-1}} \right) = \frac{\Xi_1}{\varsigma} \left(\frac{I_t}{K_{t-1}} \right)^{\varsigma} + \Xi_2. \tag{29}$$

The two parameters Ξ_1 and Ξ_2 are designed to make the adjustment cost vanish in the steady state.

[2] We can show that $\tilde{\mathrm{R}}_{t,s} \equiv \prod_{j=1}^{s} \left[R_{t+j} \frac{p_{t+j-1}}{p_{t+j}} \right]^{-1} = \beta^s \frac{\lambda_{t+s}}{\lambda_t} \frac{p_t}{p_{t+s}}$, where λ_t is the aggregate shadow value of firms' profits in the household budget constraint.

By combining the first order conditions, it can be easily shown that:

$$\nu_t K_t = \frac{\left[(1-\tau_K)\frac{r_{t+1}}{p_{t+1}} + \tau_K \delta_K\right] K_t - I_{t+1} + \nu_{t+1} K_{t+1}}{R_{t+1}\frac{p_t}{p_{t+1}}}. \tag{30}$$

Hence, iterating on the previous expression and imposing the standard transversality condition yields:

$$\nu_t K_t = \sum_{s=t+1}^{\infty} \tilde{\mathrm{R}}_{t,s} \left\{\left[(1-\tau_K) r_s + \tau_K \delta_K p_s\right] K_{s-1} - p_s I_s\right\}. \tag{31}$$

The right-hand side in (**??**) represents the discounted flow of future cash flows in real terms, i.e. the stock market value of claims to physical capital. This implies that:

$$V_t = p_t \nu_t K_t. \tag{32}$$

Combining (**??**), (**??**), (**??**) and (**??**), we get the following law of motion for net foreign assets:

$$F_t = R_t F_{t-1} + \mathcal{H}_t + \left[(1-\tau_K) r_t + \tau_K \delta_K p_t\right] K_{t-1} - \mathcal{Z}_t C_t - p_t I_t - (G_t - T_t). \tag{33}$$

2.3 Firms and Unions

Firms produce intermediate and final goods, and distribute imported intermediate goods. We assume that there is a single representative firm producing the final good Y under perfect competition. This firm combines $\mathcal{N}$ intermediate goods using a CES production function, possibly with increasing returns in the variety of intermediate inputs.

Local firms in the intermediate goods sector produce N varieties of differentiated goods, operating under monopolistic competition. A share Θ of these N locally produced varieties cannot be traded (exported). The remaining $(1-\Theta)$ can be exported.

Furthermore, other $(1-\Theta^*)\,\mathrm{N}^*$ varieties are imported and distributed, where N^* indicates the total number of foreign produced varieties, and Θ^* the share of them that can be imported. Hence, the total number of varieties is given by $\mathcal{N} = \mathrm{N} + (1-\Theta^*)\,\mathrm{N}^*$. These foreign varieties are combined with capital and labour inputs by the distributors. The distributed intermediate goods can be either sold locally (to the final good producer) or exported. The first possibility represents the use of distributed imported varieties in the local economy while the second possibility captures re-export in the model, which helps to capture the particulalry large trade flows between a small open economy such as Luxembourg and the rest of the world. The use of capital and labour in the distribution of these imported intermediate goods follows Mazenga and Ravn (1998, 2004).

Each firm in the intermediate goods sector adopts a nested CES production production function with capital and two different types of labour as inputs. The firm chooses the optimal demand of capital and each type of labour by maximizing profits subject to the production function constraint, taking wages and the cost of capital as given. The cost of capital is determined endogenously in order to match demand and supply of capital. For the sake of exposition, we will first present all the derivations for a generic production function, and then specialize the results to the nested CES case, which requires a more complex notation.

Each distributor of imported intermediate goods adopts a Leontief type production function, with imported foreign intermediate varieties and a nested CES combination of capital and two different types of labour as inputs. The firm chooses the optimal demand of the intermediate varieties imported, of capital and each type of labour by maximizing profits subject to the production function constraint, taking prices of the varieties, wages and the cost of capital as given.

Wages are determined by the interaction between the firms in the intermediate goods and distribution sector and the unions, which represent the workers (the so-called "right to manage" model). In particular, we assume that there is a union for each type of workers, and that bargaining with the firm takes place in a Nash setting. We assume that there is a separate union for each firm, but this is not a restrictive hypothesis since in symmetric equilibrium firms will make the same choices in terms of demand for labour and capital. Given the resulting wages, labour demand is determined, and it is assumed that for the current wages the supply of each type of labour adjusts to meet demand.

Technically, the interaction between the production and labour markets is represented as a game in two stages, where wage bargaining takes place in the first stage and production in the second. As in Lockwood (1990), the second stage is solved first, and the solution is used in the first stage. Therefore, after discussing the final good sector, we will first describe the problem of the firms (second stage), and then the firm-union bargain (first stage). We will deal, in turn, with producers of non-tradable goods, tradable goods, and importers of foreign intermediate goods.

2.3.1 Final good sector

The cost function for the final good producing firm is:

$$\mathcal{C}_F\left(\{p_j\}, Y\right) \equiv \min_{\{y_j\}} \sum_{j=1}^{\mathcal{N}} p_j y_j, \tag{34}$$

$$\text{s.t. } \mathcal{N}^{\rho-\mu}\left(\sum_{j=1}^{\mathcal{N}} y_j^{\frac{1}{\mu}}\right)^{\mu} \geq Y, \tag{35}$$

where y_j is the amount of the j^{th} intermediate good used for production of the final good Y, $j = 1, ..., \mathcal{N}$; $\mu > 1$ is indirectly related to the elasticity of substitution between goods and directly related to the mark-up in the intermediate goods sector; and $\rho \geq 1$ is a parameter that captures increasing returns to variety; see Kim (2004) for details.

The conditional demand for intermediate good j equals:

$$y_j = \frac{p_j^{\frac{\mu}{1-\mu}} Y}{\mathcal{N}^{\rho-\mu}\left(\sum_{s=1}^{\mathcal{N}} p_s^{\frac{1}{1-\mu}}\right)^{\mu}}. \tag{36}$$

The unit cost function becomes the following:

$$\mathcal{C}_F\left(\{p_j\}, 1\right) = p = \mathcal{N}^{-(\rho-\mu)}\left(\sum_{j=1}^{\mathcal{N}} p_j^{\frac{1}{1-\mu}}\right)^{1-\mu}. \tag{37}$$

Therefore, the conditional demand for intermediate good j can be written as:

$$y_j = \left(\frac{p_j}{p}\right)^{\frac{\mu}{1-\mu}} Y\mathcal{N}^{\frac{\rho-\mu}{\mu-1}}. \tag{38}$$

2.3.2 Intermediate goods sector - Non-tradable goods: $j \in [1, \Theta \mathrm{N}]$

Second stage: profit maximization The problem of a generic firm in the intermediate goods sector producing a non-tradable good can be formulated as:

$$\begin{aligned}\max_{\left\{h_{zj}^{NT}, k_j^{NT}\right\}} \pi_j^{NT} \quad \equiv \quad & p_j^{NT}\left(y_j^{NT}\right) y_j^{NT} - \left(1+\psi_K i^W\right) r k_j^{NT} + \\ & - \left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right) \sum_{z=1}^{2} w_{zj}^{NT} h_{zj}^{NT} - \psi_j,\end{aligned} \tag{39}$$

where $p(y_j^{NT})$ indicates the price of the j^{th} non-tradable intermediate good; h_{zj}^{NT}, $z = 1, 2$, the amount of the two types of labour (resident and non-resident) and and k_j^{NT} capital; ψ_j is a fixed financial cost to enter the market (the fixed cost generates economies of scale and therefore justifies monopolistic competition; see Kim, 2004); ψ_L and ψ_K denote the fraction of wage and rental bills, respectively, that must be financed in advance ($\psi_L = \psi_K = 0$ in Deak et al. (2011)), while i_t^W denotes the net interest rate firms pay on the working-capital to meet these advance payments[3]; and $\tilde{\tau}_L$ represents taxes on labour (social contributions) paid by firms; labour income taxes paid by workers will be taken into account later. In addition:

$$p_j^{NT}\left(y_j^{NT}\right) = \mathcal{N}^{\frac{\rho-\mu}{\mu}} \left(\frac{y_j^{NT}}{Y}\right)^{\frac{1-\mu}{\mu}} p, \tag{40}$$

$$y_j^{NT} = f\left(k_j^{NT}, h_{1j}^{NT}, h_{2j}^{NT}\right), \tag{41}$$

where the specific functional form for the production function will be discussed later on.

The first order conditions can be written as:

$$p_j^{NT} \frac{\partial y_j^{NT}}{\partial h_{zj}^{NT}} = \mu\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right) w_{zj}^{NT}, \tag{42}$$

$$p_j^{NT} \frac{\partial y_j^{NT}}{\partial k_j^{NT}} = \mu\left(1+\psi_K i^W\right) r. \tag{43}$$

Note that, thanks to the Envelope Theorem:

$$\frac{\partial h_{zj}^{NT}}{\partial w_{zj}^{NT}} = \frac{1}{w_{zj}^{NT}} \left[(1-\mu)\frac{\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right) w_{zj}^{NT}}{p_j^{NT} y_j^{NT}} + \frac{\partial^2 y_j^{NT}}{\left(\partial h_{zj}^{NT}\right)^2}\left(\frac{\partial y_j^{NT}}{\partial h_{zj}^{NT}}\right)^{-1}\right]^{-1}. \tag{44}$$

[3] Notice that we assume firms pay taxes on labour, $\tilde{\tau}_L w_{zj}^{NT} h_{zj}^{NT}$, at the same time when wages. Thus, firms must also borrow working capital to pay ψ_L fraction of the labour tax in advance. Another option would be to have wage costs entering the firms' profit function formulated as $\left(1+\tilde{\tau}_L+\psi_L i_t^W\right) w_{zj}^{NT} h_{zj}^{NT}$. The underlying assumption behind this formulation is that taxes are paid at the end of the period and thus working capital is required only for the advance payment of net wages. Since in our model a period is one year and firms pay taxes more frequently than annually we choose the first formulation.

First stage: firm-union bargaining (labour market) We follow the standard "right-to-manage" approach and assume that each firm-union pair bargains over type-z wage, taking the labour demand curve into account. The outcome of the bargaining process can be depicted as the solution of the following maximization problem:

$$\max_{w_{zj}^{NT}} \Omega^{NT} \equiv \left[(1-\tau_L)\left(\frac{w_{zj}^{NT}}{p}-\frac{\bar{w}_z}{p}\right)h_{zj}^{NT}\right]^{\theta_z^{NT}}\left[\frac{\tilde{\pi}\left(w_{zj}^{NT}\right)}{p}\right]^{1-\theta_z^{NT}}, \tag{45}$$

where θ_z^{NT} is a parameter describing the relative bargaining power of the union for type z workers (possibly sector-specific), $\bar{w}_z$ the workers' outside option, and:

$$\tilde{\pi}^{NT}\left(w_{zj}^{NT}\right) = p^{NT}\left[f\left(k_j^{NT},h_{1j}^{NT},h_{2j}^{NT}\right)\right]f\left(k_j^{NT},h_{1j}^{NT},h_{2j}^{NT}\right)+ \tag{46}$$

$$-\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\sum_{z=1}^{2}w_{zj}^{NT}h_{zj}^{NT}. \tag{47}$$

For $z=1,2$, the wage equations can be written as:

$$\theta_z^{NT}\left(1+\frac{w_{zj}^{NT}-\overline{w}_{z,t}}{w_{zj}^{NT}}\epsilon_{zj}^{NT}\right)\frac{\tilde{\pi}_j^{NT}}{h_{zj}^{NT}}=\left(1-\theta_z^{NT}\right)\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\left(w_{zj}^{NT}-\bar{w}_{z,t}\right), \tag{48}$$

where:

$$\epsilon_{zj}\equiv\frac{\partial h_{zj}^{NT}}{\partial w_{zj}^{NT}}\frac{w_{zj}^{NT}}{h_{zj}^{NT}}. \tag{49}$$

We will derive similar equations for the tradable intermediate goods sector in the next subsection. Several factors affect real wages. First, as usual, labour productivity. Second, the characteristics of the labour market, such as the union power θ and the replacement ratios $\bar{w}_j/w_j$. Third, the profit rate, since unions extract some of the producer surplus. Fourth, the relative productivity of the two types of labour, the relative size of the labour forces, and the unemployment rates. Finally, the relative productivity with respect to capital and the amount of capital per worker.

2.3.3 Intermediate goods sector - Tradable goods: $j \in [\Theta \mathrm{N}, \mathrm{N}]$

Second stage: profit maximization Let us now consider the problem of a generic firm in the intermediate goods sector producing tradable goods, y_j^T, such that $y_j^H = s_j^H y_j^T$ is sold at home and $y_j^F = s_j^F y_j^T$ is exported ($s_j^F = 1 - s_j^H$, and $0 \leq s_j^H \leq 1$), with corresponding prices given by p_j^H and p_j^F. The firm should choose the amount of labour and capital to be used for the production of y_j^T (h_{zj}^T and k_j^T, respectively, $z=1,2$), and the share of y_j^T sold at home, s_j^H, to optimize the following problem:

$$\max_{\left\{h_{zj}^T,k_j^T,s_j^H\right\}}\pi_j^T\equiv p_j^T\left(y_j^T\right)y_j^T-\left(1+\psi_K i^W\right)rk_j^T-\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\sum_{z=1}^{2}w_{zj}^T h_{zj}^T-\psi_j,$$

where:

$$p_j^T = s_j^H p_j^H + s_j^F p_j^F, \tag{50}$$

$$s_j^F = 1 - s_j^H, \tag{51}$$

$$y_j^T = f\left(k_j^T, h_{1j}^T, h_{2j}^T\right), \tag{52}$$

$$p_j^H = \mathcal{N}^{\frac{\rho-\mu}{\mu}} \left(\frac{s_j^H y_j^T}{Y}\right)^{\frac{1-\mu}{\mu}} p, \tag{53}$$

$$p_j^F = \left(1-t^F\right)\left(\mathcal{N}^*\right)^{\frac{\rho-\mu}{\mu}} \left(\frac{s_j^F y_j^T}{Y^*}\right)^{\frac{1-\mu}{\mu}} p^*. \tag{54}$$

Note that Y^* and p^* represent foreign output and the foreign aggregate price. Furthermore, note that the elasticity of substitution between intermediate goods is the same at home and abroad, i.e. $\mu^* = \mu$: this assumption is maintained for notational simplicity, but the model can be easily generalized.[4] As in the non-tradable sector, ψ_j is a fixed financial cost to enter the market that generates economies of scale and therefore provides a basis for monopolistic competition (see Kim (2004)).

The first order conditions can be written as:

$$p_j^T \frac{\partial y_j^T}{\partial h_{zj}^T} = \mu\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right) w_{zj}^T, \tag{55}$$

$$p_j^T \frac{\partial y_j^T}{\partial k_j^T} = \mu\left(1+\psi_K i^W\right) r. \tag{56}$$

Again, we can show that:

$$\frac{\partial h_{zj}^T}{\partial w_{zj}^T} = \frac{1}{w_{zj}^T}\left[(1-\mu)\frac{\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right) w_{zj}^T}{p_j^T y_j^T} + \frac{\partial^2 y_j^T}{\left(\partial h_{zj}^T\right)^2}\left(\frac{\partial y_j^T}{\partial h_{zj}^T}\right)^{-1}\right]^{-1}. \tag{57}$$

First stage: firm-union bargaining (Labour market) The firm-union bargain is similar to that in the non-tradable sector. The wage equations become the following:

$$\theta_z^T\left(1+\frac{w_{zj}^T-\overline{w}_z}{w_{zj}^T}\epsilon_{zj}^T\right)\frac{\tilde{\pi}_j^T}{h_{zj}^T} = \left(1-\theta_z^T\right)\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\left(w_{zj}^T-\overline{w}_z\right), \tag{58}$$

where:

$$\tilde{\pi}_j^T = p_j^T y_j^T - \left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\sum_{z=1}^{2} w_{zj}^T h_{zj}^T, \tag{59}$$

$$\epsilon_{zj}^T \equiv \frac{\partial h_{zj}^T}{\partial w_{zj}^T}\frac{w_{zj}^T}{h_{zj}^T}. \tag{60}$$

2.3.4 Intermediate goods sector - Distribution of imported varieties

Second stage: profit maximization Since this sector is fairly different from that in Deak et al. (2011), we describe it in some detail. The generic distributor of imported intermediate varieties produces tradable

[4] The distinction between local and foreign elasticities is important to study shocks to local markups that do not transmit to markups in foreign markets. In this case, we obviously use the generalized version of the model.

intermediate goods, y_j^M, such that $y_j^{M,H} = s_j^{M,H} y_j^M$ is sold in the home market and $y_j^{M,F} = (1 - s_j^{M,H}) y_j^M$ is re-exported ($0 \leq s_j^{M,H} \leq 1$). The corresponding prices are $p_j^{M,H}$ and $p_j^{M,F}$. The main feature that distinguishes the distributor of imported varieties from the tradable intermediate goods producers is that the former use foreign varieties imported at the price p_M^* as well as capital and labour to produce their services of distribution. Apart from this difference the profit maximization problems in the two sectors are very similar:

$$\begin{aligned} \max_{\left\{x_j^M, h_{zj}^M, k_j^M, s_j^{M,H}\right\}} \pi_j^M \quad \equiv \quad & p_j^M \left(y_j^M\right) y_j^M - \left(1 + t^M\right) p_M^* x_j^M + \\ & - \left(1 + \psi_K i^W\right) r k_j^M - \left(1 + \tilde{\tau}_L\right) \left(1 + \psi_L i^W\right) \sum_{z=1}^{2} w_{zj}^M h_{zj}^M - \psi_j, \end{aligned} \tag{61}$$

where x_j^M denotes the imported amount of the foreign intermediate good. The maximization problem is subject to:

$$p_j^M = s_j^{M,H} p_j^{M,H} + s_j^{M,F} p_j^{M,F}, \tag{62}$$

$$s_j^{M,F} = 1 - s_j^{M,H}, \tag{63}$$

$$y_j^M = \min\left[\pi_1 x_j^M, f^M\left(k_j^M, h_j^M\right)\right], \tag{64}$$

$$p_j^{M,H} = \mathcal{N}^{\frac{\rho-\mu}{\mu}} \left(\frac{s_j^{M,H} y_j^M}{Y}\right)^{\frac{1-\mu}{\mu}} p, \tag{65}$$

$$p_j^{M,F} = \left(1 - t^F\right) \left(\mathcal{N}^*\right)^{\frac{\rho-\mu}{\mu}} \left(\frac{s_j^{M,F} y_j^M}{Y^*}\right)^{\frac{1-\mu}{\mu}} p^*. \tag{66}$$

Equation (**??**) implies that imports of foreign intermediate goods are perfect complements to local distribution services, produced via capital and labor, as in Ravn and Mazzenga (2004). Cost minimization implies that $\pi_1 x_j^M = f^M\left(k_j^M, h_j^M\right)$; therefore, in equilibrium $x_j^M = y_j^M / \pi_1$. For the sake of simplicity, let's anticipate this equilibrium outcome, and rewrite the maximization problem as:

$$\begin{aligned} \max_{\left\{h_{zj}^M, k_j^M, s_j^{M,H}\right\}} \pi_j^M \quad \equiv \quad & \left[p_j^M\left(y_j^M\right) - \left(1 + t^M\right) \frac{p_M^*}{\pi_1}\right] y_j^M + \\ & - \left(1 + \psi_K i^W\right) r k_j^M - \left(1 + \tilde{\tau}_L\right) \left(1 + \psi_L i^W\right) \sum_{z=1}^{2} w_{zj}^M h_{zj}^M - \psi_j. \end{aligned} \tag{67}$$

The first order conditions can be written as:

$$\left[p_j^M - \mu\left(1 + t^M\right) \frac{p_M^*}{\pi_1}\right] \frac{\partial y_j^M}{\partial h_{zj}^M} = \mu\left(1 + \tilde{\tau}_L\right) \left(1 + \psi_L i^W\right) w_{zj}^M, \tag{68}$$

$$\left[p_j^M - \mu\left(1 + t^M\right) \frac{p_M^*}{\pi_1}\right] \frac{\partial y_j^M}{\partial k_j^M} = \mu\left(1 + \psi_K i^W\right) r. \tag{69}$$

The resulting profits are:

$$\pi_j^M = \left(1 - \frac{1}{\mu}\right) p_j^M y_j^M - \psi_j.$$

while the value added amounts to:

$$va_j^M = \left[p_j^M - \left(1 + t^M\right) \frac{p_M^*}{\pi_1}\right] y_j^M - \psi_j. \tag{70}$$

As before, the Envelope Theorem allows us to write:

$$\frac{\partial h_{zj}^M}{\partial w_{zj}^M} = \frac{1}{w_{zj}^M}\left[\frac{\frac{1-\mu}{\mu}\frac{p_j^M}{y_j^M}\frac{\partial y_j^M}{\partial h_{zj}^M}}{p_j^M - \mu\left(1+t^M\right)\frac{p_M^*}{\pi_1}} + \frac{\partial^2 y_j^M}{\left(\partial h_{zj}^M\right)^2}\left(\frac{\partial y_j^M}{\partial h_{zj}^M}\right)^{-1}\right]^{-1}. \tag{71}$$

First stage: firm-union bargaining (Labour market) The firm-union bargain is similar to that in the non-tradable sector. The wage equations boil down to:

$$\theta_z^M\left(1+\frac{w_{zj}^M - \bar{w}_{z,t}}{w_{zj}^M}\epsilon_{zj}^M\right)\frac{\tilde{\pi}_j^M}{h_{zj}^M} = \left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\left(1-\theta_z^M\right)\left(w_{zj}^M - \bar{w}_z\right), \tag{72}$$

where:

$$\tilde{\pi}_j^M = \left[p_j^M - \mu\left(1+t^M\right)\frac{p_M^*}{\pi_1}\right]y_j^M - \left(1+\tilde{\tau}_L\right)\left(1+\psi_L i^W\right)\sum_{z=1}^{2} w_{zj}^M h_{zj}^M, \tag{73}$$

$$\epsilon_{zj}^M \equiv \frac{\partial h_{zj}^M}{\partial w_{zj}^M}\frac{w_{zj}^M}{h_{zj}^M}. \tag{74}$$

2.4 Domestic banking sector

There exists a representative, competitive bank that intermediates loans between households and firms, producing financial services using capital, labor and reserves. The bank is owned by the households. As in Christiano and Eichenbaum (1995) and Christiano, Motto and Rostagno (2008), firms (and banks themselves) need to finance a given fraction of their factor expenditure in advance, before revenues from sales can be cashed in, i.e. firms need short-term working capital.

To finance working-capital loans, the bank issues demand deposit liabilities to households. Working capital loans are made in form of demand deposits to firms. Hence, total deposits are equal to:

$$D^T = D^H + D^F. \tag{75}$$

In equilibrium, demand deposits to households will match the supply of money not held for transaction services:

$$D^H = \bar{M} - M = \bar{M} - \iota C, \tag{76}$$

where ι is the steady state version of ι_t defined in (**??**), while demand deposits to firms will be equal to the short term working capital:

$$D^F = \psi_K r K + \psi_L \sum_{z=1}^{2} w_z H_z. \tag{77}$$

The parameters ψ_L and ψ_K represent the fraction of wage and rental bills, respectively, that must be financed in advance. Demand deposits pay an interest rate i^D. Interest on demand deposits created when firms and banks receive their working-capital loans are paid to the recipient of the loan. Firms and banks hold these demand deposits until the factor bill is paid in a settlement period that occurs after the goods market. Interest paid by firms on working capital loans is denoted $i^W + i^D$. Since firms receive interest payments on deposits, the net interest rate is i_t^W. Working-capital loans and demand deposits share the

same maturity. Loans are extended just prior to production, and then paid off after production. Households deposit founds into the bank just prior to production, and then liquidate the deposit after production.

Demand deposits are associated with financial services. The bank has a technology for converting labor and capital services, and excess reserves, into transaction services:

$$\frac{D^T}{p} = Az^{CB}\left[\left(K^{CB}\right)^{\alpha^{CB}}\left(\Lambda H^{CB}\right)^{1-\alpha^{CB}}\right]^{\xi^{CB}}\left(\frac{E^{CB}}{p}\right)^{1-\xi^{CB}}, \tag{78}$$

where E^{CB} denote excess reserves, and:

$$H^{CB} = \left[\sum_{z=1}^{2}\varkappa_z\left(a_z H_z^{CB}\right)^{\kappa}\right]^{\frac{1}{\kappa}}, \tag{79}$$

where $\varkappa_1 + \varkappa_2 = 1$. Recall that loans are not used until the end of the period; excess reserves are then defined as:

$$E^{CB} = D^H - \varrho^{CB}D^T = \left(1-\varrho^{CB}\right)D^H - \varrho^{CB}D^F, \tag{80}$$

where ϱ^{CB} denotes the required reserves coefficient. Excess reserves enter the production function in order to capture the idea that banks held excess reserves for a precautionary motif, given the possibility of unexpected withdrawals.

After the goods market clears, the bank settles claims for transactions that occurred in this market. The bank's sources of funds are: interest and principal on working capital loans, plus the resources it received from households at the start of the period. The bank's uses of funds are: principal and interest payments on demand deposits, plus gross expenses on labor and capital services. Then, the bank's net source of funds at the end of the period is:

$$\Pi^{CB} = i^W D^F - i^D D^H - \left(1+\psi_K i^W\right) rK^{CB} - \left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)\sum_{z=1}^{2} w_z^{CB} H_z^{CB}. \tag{81}$$

The bank solves the following maximization problem:

$$\begin{aligned}\max_{\{D^F, D^H, K^{CB}, H_z^{CB}\}} \quad & \Pi^{CB} = i^W D^F - i^D D^H - \left(1+\psi_K i^W\right) rK^{CB} + \\ & - \left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)\sum_{z=1}^{2} w_z^{CB} H_z^{B}, \\ \text{s.t.} \quad & \frac{D^H + D^F}{p} = Az^{CB}\left[\left(K^{CB}\right)^{\alpha^{CB}}\left(\Lambda H^{CB}\right)^{1-\alpha^{CB}}\right]^{\xi^{CB}}\left(\frac{E^{CB}}{p}\right)^{1-\xi^{CB}}\end{aligned} \tag{82}$$

The first order conditions can be compactly rewritten as:[5]

$$i^D + i^W = \left[\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)-i^D\right]\left(1-\xi^{CB}\right)\frac{D^T}{E^{CB}}, \tag{83}$$

$$\left(1+\psi_K i^W\right) r = \left[\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)-i^D\right]\xi^{CB}\alpha^{CB}\frac{D^T}{K^{CB}}, \tag{84}$$

$$\left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right) w_z^{CB} = \tag{85}$$

$$\left[\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)-i^D\right]\xi^{CB}\left(1-\alpha^{CB}\right)\varkappa_z\frac{D^T}{H_z^{CB}}\left(\frac{a_z H_z^{CB}}{H^{CB}}\right)^{\kappa},$$

$$\frac{D^T}{p} = \Psi^{FB}\left(K^{CB}\right)^{\alpha^{CB}}\left(H^{CB}\right)^{1-\alpha^{CB}}, \tag{86}$$

where:

$$\Psi^{FB} \equiv \left(Az^{CB}\right)^{\frac{1}{\xi^{CB}}}\left(\Upsilon^{CB}\right)^{\frac{1-\xi^{CB}}{\xi^{CB}}}, \tag{87}$$

$$\Upsilon^{CB} \equiv \frac{\left[\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)-i^D\right]\left(1-\xi^{CB}\right)}{i^D+i^W}. \tag{88}$$

2.4.1 Bargaining

The general framework for bargaining goes through, so here we repeat those equations only that are specific to this sector. The outside option for the bank if negotiations fail can be written as $\pi^{CB} = -\left(1+\psi_K i^W\right) rK^{CB}$, which implies that the value added of successful negotiations is:

$$\tilde{\pi}^{CB} = \left[\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)-i^D\right]\xi^{CB}D^T - \left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)\sum_{z=1}^{2} w_z^{CB}H_z^{CB}. \tag{89}$$

The wage equations boil down to:

$$\theta_z^{CB}\frac{\tilde{\pi}^{CB}}{H_z^{CB}}\left(1+\frac{w_z^{CB}-\bar{w}_z}{w_z^{CB}}\epsilon_z^{CB}\right) = \left(1-\theta_z^{CB}\right)\left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)\left(w_z^{CB}-\bar{w}_z\right), \tag{90}$$

were:

$$\epsilon_z^{CB} = \left[\left(1-\alpha^{CB}-\kappa\right)\varkappa_z\left(\frac{a_z H_z^{CB}}{H^{CB}}\right)^{\kappa}+\kappa-1\right]^{-1}. \tag{91}$$

2.5 International banking sector

There exists a representative, competitive bank that intermediates loans between foreign households and foreign firms, producing financial services using capital, labor and reserves. The bank is owned by the local households. As before, the international bank needs to finance a given fraction of its factor expenditure in advance, before revenues can be cashed in. To finance the foreign demand for loans, our bank issues demand deposit liabilities to foreign households. Hence, total demand deposits are denoted D^{FH}. We assume that

[5] Equation (??) has a clear economic interpretation: if the bank increases excess reserves by one (marginal) unit, it decreases the amount of working-capital loans by the same amount, incurring therefore in an opportunity cost equal to $i^D + i^W$. This extra unit of reserves is used in the production of financial services, and increases total demand deposits D^T by its marginal productivity $\left(1-\xi^{CB}\right)\frac{D^T}{E^{CB}}$. Finally, the increase in total demand deposits will be used to increase working capital loans, and this will lead to an increase in revenues equal to $\left(1-\varrho^{CB}\right)\left(i^W+i^D\right)$, but also implies that these new loans have to be financed via households' demand deposits, that cost i^D. The other conditions have now a straightforward interpretation.

the supply of foreign demand deposits is exogenous, and D^{FB} depends positively on the interest rate paid by the international bank, denoted i^{FD}:

$$D^{FB} = \left(\frac{i^{FB}}{i}\right)^{\frac{1}{\sigma^{FB}-1}} D^*, \tag{92}$$

where $\sigma^{FB} \in (1,2)$; this implies that:

$$\frac{dD^{FB}}{di^{FB}} > 0, \quad \frac{d^2D^{FB}}{\left(di^{FB}\right)^2} < 0. \tag{93}$$

Given that foreign firms have access to the international financial market, the foreign recipient of the loans pay an interest rate equal, in equilibrium, to the exogenous international interest rate i. Loans to foreign firms and foreign demand deposits share the same maturity. Loans are extended just prior to production, and then paid off after production. Households deposit funds into the bank just prior to production, and then liquidate the deposit after production.

Foreign demand deposits are associated with financial services. The bank has a technology for converting labor and capital services, and excess reserves, into transaction services:

$$\frac{D^{FB}}{p} = Az^{FB}\left[\left(K^{FB}\right)^{\alpha^{FB}}\left(\Lambda H^{FB}\right)^{1-\alpha^{FB}}\right]^{\xi^{FB}}\left(\frac{E^{FB}}{p}\right)^{1-\xi^{FB}} = Az^{FB}\left(y^{FB}\right)^{\xi^{FB}}\left(\frac{E^{FB}}{p}\right)^{1-\xi^{FB}}, \tag{94}$$

where $E_t^{FB} = \left(1-\varrho^{FB}\right)D_t^{FB}$ denote excess reserves, and:

$$H^{FB} = \left[\sum_{z=1}^{2}\varkappa_z\left(a_z H_z^{FB}\right)^{\kappa}\right]^{\frac{1}{\kappa}}. \tag{95}$$

Hence, we can solve the production function for D^{FB}/p, getting:

$$\frac{D^{FB}}{p} = \left[\left(1-\varrho^{FB}\right)^{1-\xi^{FB}}Az^{FB}\right]^{\frac{1}{\xi^{FB}}}\left(K^{FB}\right)^{\alpha^{FB}}\left(\Lambda H^{FB}\right)^{1-\alpha^{FB}} = \Psi^{FB}\left(K^{FB}\right)^{\alpha^{FB}}\left(\Lambda H^{FB}\right)^{1-\alpha^{FB}}. \tag{96}$$

The bank's sources of funds are: interest and principal on loans to foreign firms, plus the resources it received from foreign households at the start of the period. The bank's uses of funds are: principal and interest payments on demand deposits, plus principal on loans, plus gross expenses on labor and capital services. Then, the bank's net source of funds at the end of the period is:

$$\begin{aligned}\Pi^{FB} &= \left[\left(1-\varrho^{FB}\right)i - i^{FB}\right]D^{FB} + \\ &\quad -\left(1+\psi_K i^W\right)rK^{FB} - \left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)\sum_{z=1}^{2}w_z^{FB}H_z^{FB}.\end{aligned} \tag{97}$$

The first order conditions for profit maximization are the following:

$$\left(1+\psi_K i^W\right)r = \left[\left(1-\varrho^{FB}\right)i - i^{FB}\right]\alpha^{FB}\frac{D^{FB}}{K^{FB}}, \tag{98}$$

$$\left(1+\psi_L i^W\right)\left(1+\tilde{\tau}_L\right)w_z^{FB} = \left[\left(1-\varrho^{FB}\right)i - i^{FB}\right](1-\alpha^{FB})\varkappa_z\frac{D^{FB}}{H_z^{FB}}\left(\frac{a_z H_z^{FB}}{H^{FB}}\right)^{\kappa}, \tag{99}$$

where:

$$D^{FB} = p\Psi^{FB}\left(K^{FB}\right)^{\alpha^{FB}}\left(\Lambda H^{FB}\right)^{1-\alpha^{FB}}. \tag{100}$$

2.5.1 Bargaining

As before, the general framework for bargaining goes through; hence, the wage equations become the following:

$$\theta_z^{FB}\left(1+\frac{w_z^{FB}-\bar{w}_z}{w_z^{FB}}\epsilon_z^{FB}\right)\frac{\tilde{\pi}^{FB}}{H_z^{FB}} = \left(1-\theta_z^{FB}\right)\left(1+\tilde{\tau}_L\right)\left(1+\psi_L i_t^W\right)\left(w_z^{FB}-\bar{w}_z\right), \tag{101}$$

where:

$$\epsilon_z^{FB} = \left[\left(1-\alpha^{FB}-\kappa\right)\varkappa_z\left(\frac{a_z H_z^{FB}}{H^{FB}}\right)^{\kappa}+\kappa-1\right]^{-1}. \tag{102}$$

2.6 Government

The Government budget constraint is:

$$B_t = R_t B_{t-1} + G_t - T_t, \tag{103}$$

where G and T indicate, respectively, total expenses and revenues, while B is government debt.

The Government collects revenues from taxes on the returns on financial assets (A), on profits, and on labour income (H_1 and H_2 are, respectively, resident and non-resident workers, whose wages are w_1 and w_2, unemployment benefits are $\overline{w}$; workers pay taxes at the rate τ_L and firms pay social contributions at the rate $\tilde{\tau}_L$). Furthermore, the government collects taxes on consumption and on imports. Therefore, total revenues in period t amount to:

$$\begin{aligned} T_t = {} & \tau_K\left[i_t F_{t-1} + \left(r_t - p_t\delta_K\right)K_{t-1} + \Pi_t + i_t^D\left(\bar{M}_t - \iota_t C_t\right)\right] + \\ & + \left(\tau_L + \tilde{\tau}_L\right)\left(w_{1,t}H_{1,t} + w_{2,t}H_{2,t}\right) + \\ & + \tau_L\bar{w}_{1,t}\left(1-H_{1,t}\right) + \tau_C p_t\left[1+\varkappa_t^d\left(\xi_t - \frac{1-\delta_D}{\varphi}\frac{\xi_{t-1}}{\mathcal{E}_t}\right)\right]C_t + \\ & + t^M\left(1-\Theta^*\right)\mathrm{N}^* p_M^* x^M. \end{aligned} \tag{104}$$

where t^M, Θ, N, Θ^*, N^*, p_M^* , x^M represent respectively the import tariff (considered as Government receipts by simplification), the share of domestic varieties that can be traded, the total number of domestic varieties, the share of foreign varieties that can be traded, the total number of foreign varieties, the price of these foreign varieties, the quantity imported.

Government expenditure is composed of unemployment benefits for residents ($SUBS$), transfers to non-resident workers (TRF), and core expenditure ($\bar{G}$), where the latter can be further split into other transfers to resident households (TR), public investment in infrastructures ($INFR\_INV$), and general government

consumption ($GCON$). Overall, we have:

$$\begin{aligned} G_t &= SUBS_t + TRF_t + \bar{G}_t, && (105)\\ SUBS_t &= \bar{w}_{1,t}\left(1 - H_{1,t}\right), && (106)\\ TRF_t &= TR_t^F\left(\tau_L + \tilde{\tau}_L\right) w_{2,t} H_{2,t}, && (107)\\ TR_t &= \varrho_1 \bar{G}_t, && (108)\\ INFR\_INV_t &= \varrho_2 \bar{G}_t, && (109)\\ GCON_t &= \left(1 - \varrho_1 - \varrho_2\right) \bar{G}_t. && (110) \end{aligned}$$

where $\varrho \in (0,1)$ represents the share of transfers to resident households from core government expenditure. Note that transfers TRF are modelled as a percentage (TR_t^F) of total labour taxes on non-resident workers. The stock of public infrastructures evolves according to the following accumulation equation:

$$INFR_t = \left(1 - \delta_{INFR}\right) INFR_{t-1} + INFR\_INV_t, \tag{111}$$

and affects Total Factor Productivity via a purely external effect (see Section 4.1 and Appendix B for further details). Note that δ_{INFR} represents the depreciation rate for public infrastructures.

We further assume that core government expenditure is persistent and depends on the part of the (primary) deficit which excludes core government expenditure, $T_t - (G_t - \bar{G}_t)$:

$$\bar{G}_t = \vartheta \bar{G}_{t-1} + \left(1 - \vartheta\right) d^{LR} \left[T_t - \bar{w}_{1,t}\left(1 - H_{1,t}\right) - TR_t^F\left(\tau_L + \tilde{\tau}_L\right) w_{2,t} H_{2,t}\right]. \tag{112}$$

This specification of the Government sector implies a zero public debt and deficit in steady state when $d^{LR} = 1$. Otherwise, a value of $d^{LR} > 1$, combined with that of the other variables and parameters in (**??**), determines the equilibrium level of debt and deficit. Note that the parameter ϑ measures the persistence of core government expenditure.

2.7 Symmetric equilibrium

In a symmetric equilibrium for all firms in a given sector the prices charged for the differentiated goods and the quantities produced are the same, i.e., $p_j^i = p^i$ and $y_j^i = y^i$, where $i = NT, T, M$. Furthermore, the equilibrium is characterized by the optimality conditions for households and government. We set the numeraire as the price of the non-traded goods: $p^{NT} = 1$. This leads us to define the following aggregate variables:

$$p = \mathcal{N}^{\mu-\rho} \left[\begin{array}{c} \Theta \mathrm{N} \left(p^{NT}\right)^{\frac{1}{1-\mu}} + \left(1-\Theta\right) \mathrm{N} \left(p^{H}\right)^{\frac{1}{1-\mu}} \\ + \left(1-\Theta^*\right) \mathrm{N}^* \left(p^{M,H}\right)^{\frac{1}{1-\mu}} \end{array} \right]^{1-\mu}, \tag{113}$$

$$H_z = \left[\Theta h_z^{NT} + \left(1-\Theta\right) h_z^T\right] \mathrm{N} + \left(1-\Theta^*\right) \mathrm{N}^* h_z^M + H_z^{CB} + H_z^{FB}, \tag{114}$$

$$w_z = \frac{\left[\Theta h_z^{NT} w_z^{NT} + \left(1-\Theta\right) h_z^T w_z^T\right] \mathrm{N} + \left(1-\Theta^*\right) \mathrm{N}^* h_z^M w_z^M + H_z^{CB} w_z^{CB} + H_z^{FB} w_z^{FB}}{H_z}, \tag{115}$$

$$K = \left[\Theta k^{NT} + \left(1-\Theta\right) k^T\right] \mathrm{N} + \left(1-\Theta^*\right) \mathrm{N}^* k^M + K^{CB} + K^{FB}, \tag{116}$$

$$\Pi = \left[\Theta \pi^{NT} + \left(1-\Theta\right) \pi^T\right] \mathrm{N} + \left(1-\Theta^*\right) \mathrm{N}^* \pi^M. \tag{117}$$

In the Appendix we specialize the analysis of the production sector and labour market to the case of a CES production function. A summary of the equilibrium conditions for the various sectors under the case of these CES production functions is available from the authors on request.

3 Calibration and steady state analysis

As an empirical illustration of our model, we choose Luxembourg, a small open economy with a large financial sector. Due to the complexity of our DSGE model, and the availability of only 15 years of quarterly observations for Luxembourg, the model cannot be estimated and we have to fully calibrate it. In this section we summarize the calibration procedure for the model parameters, and then discuss the resulting steady state. Additional details, including a list of all the model parameters and their calibrated values, are available upon request.

3.1 Calibration

We can divide the model parameters into three groups according to how we set their values. The parameters in the first group are set directly to standard values in the DSGE literature. In particular, we fix the subjective discount rate (β) to 0.995, the elasticity of intertemporal substitution to unity (i.e. $\sigma = 1$ which implies that preferences are logarithmic), the weight of capital in the production functions in all sectors (α, α^{CB} and α^{FB}) to 0.36 (the implied capital share in production is 39%), the persistence of core government expenditure (ϑ) to 0.9, the returns to variety to zero (which implies that $\rho = 1$), the elasticity of substitution among intermediate goods to 6 (so that $\mu = 1.2$), the persistence of the stochastic, persistent, but stationary component of productivity to 0.95 and the elasticity of substitution between the two labour types in the CES labour aggregator to 1.5 (so that $\kappa = 1/3$).[6] We set the relative bargaining power of the unions (θ_z^I, $I = T, NT, M, CB, FB$) to 0.35 for the tradable and non-tradable intermediate goods producers, to 0.27 for the distributors of imported intermediate goods, and to 0.65 for the domestic and international banks. These values attribute a negotiation power to the unions that may be larger than in many other small open economies. Hence, this peculiarity has to be kept in mind when interpreting the results of the simulations. To assess their robustness to the choice of tbe unions' bargaining power, we also discuss results based on different values in Section 4.6.

We follow Backus, Henriksen, and Storesletten (2008) in setting the depreciation rate on physical capital (δ_K) to 8.5% and on the stock of public infrastructure (δ_{INFR}) to 4.15%. We set the elasticity of the international interest rate with respect to the national debt/GDP ratio (ξ_i) to 0.000742 based on Schmitt-Grohe and Uribe (2004). Following Boldrin, Christiano, and Fisher (2001) we assume that the elasticity of the adjustment cost with respect to the investment-capital ratio is 0.23 (so that $\varsigma = -3.348$).

We set the parameter related to the elasticity of substitution between durables and non-durables in the

[6] Guarda (2000) actually found evidence of complementarity between these labour types in Industry and in Services, but he was using a Translog production functin with gross output (instead of value added) and intermediate consumption. In addition, his sample covered 1984-1996 using unpublished national accounts data prior to the introduction of ESA95. Thus, these past results may not be relevant for the current analysis.

utility function (υ) in order to reproduce an elasticity of substitution equal to 1.5. The percentage of total labour taxes on non-resident workers that is transferred back to non-resident workers (TR_t^F) is chosen to be 0.6. We choose a small value for the fixed cost to enter the market of intermediate good j (ψ_j) and set it equal to 0.00001. The parameter related to the elasticity of TFP with respect to public infrastructure (ϖ) is chosen to be equal to 0.01.

Next, we normalize the foreign aggregate price level (P^*), the labour-augmenting productivity parameter (Λ) and the parameters augmenting type-1 (a_1) and type-2 (a_2) labour in the labour CES aggregator to unity. We also assume that Luxembourg and the rest of the world are symmetric in terms of the share of non-traded varieties, both Θ and Θ^* are equal to 0.5. We normalize the number of traded varieties to unity, which implies that we set both N and N^* equal to 2, again for the sake of symmetry.

We follow Christiano, Motto and Rostagno (2008, 2010) by setting the fraction of the rental and wage bills the firms must finance in advance (ψ_K and ψ_L) to 92% and the required reserves coefficients for both the domestic and international banks (ϱ^{CB} and ϱ^{FB}) to 2%. We set the parameter related to the elasticity of foreign demand deposits to the interest rate paid by the international bank (σ^{FB}) to 1.5.

For the second parameter group, some values are directly observable or can be estimated. Average life expectancy at birth in Luxembourg was 79.18 years in 2008 (CIA factbook) which implies that the individual survival rate in our model (φ) is 0.987. The average value of net foreign position ($\bar{f}$) was 85% of GDP at the end of 2007 an 2008 (according to the BcL bulletin). The population growth rate in Luxembourg is 1.2% (data from CIA factbook, year 2008) which implies that η equals to 1.012.

We average depreciation rates for durable goods owned by consumers estimated by the Bureau Economic Analysis over all types of durable goods and set the depreciation rate on durables (δ_D) to 21.7%.

Guarda (1997) estimates the elasticity of substitution between capital and labour in a CES production function to be 1.012 in the tradables sector in Luxembourg (implies that $\lambda = 0.012$). We set the share of type-1 labour in the labour CES aggregator ($\varkappa_1$) to 0.6 to reflect the fact that approximately 60% of the employed workforce is resident.

We set the tax rates according to the values reported in *Taxation trends in the EU*, European Commission, 2008. In particular, the tax rate on consumption (τ_C) equals to 25.1%. The total average effective tax rate on labour related income is 29.6%, but only 67.9% of this amount is paid by the employee while the remaining part is paid by the employer. Thus, we set the tax rate on labour related income (τ_L) to 20.1% and the social contribution rate on labour related income ($\tilde{\tau}_L$) to 9.5%. Estimates of the tax rate on capital income (τ_K) are not reported in the mentioned source due to data availability problems, so we take the average effective tax rate on corporate profits as a useful approximation, and set the parameter equal to 29.6%.

The average TFP growth rate (γ) in Luxembourg over 1995-2009, as reported in the Annual Report of the Luxembourg Central Bank (2006, p. 54) was 0.6%.

We use the Overall Trade Restrictiveness Index (Kee, Nicita and Olarreaga, 2009) for the European Union to set the tariffs in the model at 6.6%. The ad-valorem equivalent of all tariff and non-tariff barriers that the European Union imposed against foreign imports was equal to 6.6% in 2006.[7] However, in Luxembourg

[7] The 2008 value is slightly lower (5.8%) but the impact is negligible. More importantly, these indices were calculated for goods only. There is ample evidence that ad valorem equivalents of barriers to trade in services are much higher. Accordingly

94.5% of all imported goods were originated from countries within the EEA in 2007 and no tariffs were applied on them. Thus, the average effective tariff on imported goods was 0.363%, which is a weighted average of zero and 6.6%, where the weights are the respective import shares. Similarly, 88.2% of all exported goods from Luxembourg in 2007 were sold within the EEA and were exempt from tariffs. The remaining share of exported goods were subject to a tariff rate of 9%, which is the MA-OTRI in 2006 for the European Union. Thus, the effective tariff on exported goods is 1.062%, which is a weighted average of zero and 9%, where the weights are the respective export shares.

In the third group there are fifteen model parameters that we calibrate jointly so that the resulting steady state matches values observed in the data.

The relative weight of durables, non-durables and money holdings kept for transaction services in the utility function (ϕ_C, ϕ_D and ϕ_M) are calibrated in order to reproduce: i) the share of durables consumption in household final consumption expenditure (average annual share between 1995-2008) 0.116, ii) the ratio between nominal consumption of non-durables and the currency stock in the households' hands (the velocity of money) equal to 7 (average between 2006-2009, OECD data), and iii) their sum is normalized to unity. The fixed individual endowment of money ($\bar{m}$) is calibrated to reproduce the interest rate on demand deposits i^D equal to 1.94% (OECD-STAN data).

The constant and exogenous long-run interest rate equals $\bar{\imath}$ if the country settles down to a net foreign position equal to its steady-state value. We calibrate its value to match the observed net asset foreign position at 85% of GDP in Luxembourg (represented by $\bar{f}$). The parameter related to the long-run debt/GDP ratio (d^{LR}) is calibrated in order to reproduce the observed debt/GDP ratio of Luxembourg equal to 0.069.

The share of transfers to resident households (ϱ_1) and the share of public investment in infrastructures (ϱ_2) in core (government) expenditure are calibrated in order to make the model replicate the share of government transfers in total government expenditure (data from OECD annual national accounts, years 2003-2007) and the share of government investment in total government expenditure (data from OECD annual national accounts, years 2003-2007). The replacement ratio of unemployment benefit for domestic workers ($REP1$) and the replacement ratio of unemployment benefit for foreign workers ($REP2$), are both expressed as a share of the total gross income of employed domestic workers. These are calibrated in order to replicate a 5% unemployment rate of type-1 workers and a ratio of type-1 to type-2 workers equal to 1.4238. The calibrated parameter values are reported in Appendix B.

The sector specific productivity parameters of the domestic (z^{CB}) and the international (z^{FB}) banks are restricted to be the same across banks and are jointly calibrated to reproduce the observed ratio between interest rates on demand deposits (i^D) and working capital ($i^D + i^W$) equal to 2 (OECD-STAN data). We also set the two parameters related to the share of demand deposits in the production function of the domestic and international banks (ξ^{CB} and ξ^{CB}) to be the same accross banks and calibrate this common value in order to replicate the observed ratio between demand deposits to households (d^H) and to firms (D^T) equals to 0.07 (OECD-STAN data). We calibrate the value of the foreign demand deposit level (D^*) to reproduce the observed ratio between net export of services (service trade balance) and GDP equal to 46.82% (average

protection faced by Luxembourg exports is underestimated, though most of the exports are to the rest of the EU with no barriers. We decided not to take this into account as no exhaustive data is available for services.

of annual values 2005-2008, data from CIA factbook 2008).

Finally, the foreign real output level (Y^*), the price of imported goods (p_M^*) and the foreign demand deposit level (D^*) are calibrated to match international trade flows. The foreign real output level (Y^*) and the price of imported goods (p_M^*) are calibrated to reproduce the share of goods exports and goods import in GDP equal to 59.5% and 47.8% (average of annual values 2005-2008, data from CIA factbook 2008), respectively. We normalize the weights on imported foreign varieties in the production function in the distribution sector (π_1) to unity. We then calibrate the weights on capital and labor (π_2) to make the model replicate the share of the transport sector value added in GDP. The latter is adjusted to account for the share of international transport services only in GDP, as in Ravn and Mazzenga (2004), giving a value of 2.5% of GDP (average of annual values between 1995-2009, OECD-STAN data).

3.2 Steady state

We now discuss the steady state resulting from the calibration. To start with, we can easily recover the national accounting identity:

$$GDP_t = p_t \left[1 + \varkappa_t^d \left(\xi_t - \frac{1-\delta_D}{\varphi}\frac{\xi_{t-1}}{\mathcal{E}_t}\right)\right] C_t + p_t I_t + GCON_t + INFR\_INV_t + NX_t,$$

where net trade can be derived from the definition of the balance of payments:

$$NX_t = F_t - (1+i_t)\, F_{t-1} + \left[1 - \tau_L + TR_t^F\,(\tau_L + \tilde{\tau}_L)\right] w_{2,t} H_{2,t}. \tag{118}$$

The shares of consumption, investment and public expenditure in GDP turn out to be about 38.6%, 28.6% and 15.9%, respectively, while net exports to GDP is about 16.9%. These values are fairly similar to the actual ones for Luxembourg prior to the crisis period. For example, the corresponding shares for the year 2000 derived from national accounts data are, respectively, 40.9%, 23.1%, 15.1% and 20.9%.

GDP can be also decomposed as

$$GDP_t = (1+\tilde{\tau}_L)\, w_{1,t} H_{1,t} + (1+\tilde{\tau}_L)\, w_{2,t} H_{2,t} + r_t K_{t-1} + \Pi_t + i_t^D \left(\bar{M}_t - \iota_t C_t\right) + t^M \left(1 - \Theta^*\right) \mathrm{N}^* p_M^* x_t^M,$$

where $i_t^D\,(\iota_t C_t - \bar{m})$ represents the opportunity cost of holding money for transaction services. In this case, the respective shares of wages, profits and returns on capital to GDP are about 51.6%, 18.7% and 29.3%. According to national account data for the year 2000, the compensation of employees to GDP ratio was only slightly lower, at 46.3%, while the operating surplus to GDP ratio was about 41.4%.

In terms of production factors, employment of resident workers is about 95% of the labour force, corresponding to an unemployment rate of about 5% to be compared with an actual value of 3.6% in 2000, increasing afterwards, in particular due to the crisis (up to 7.8% in 2010). According to our calibration, about 54% of the resident labour force is employed in the banking sectors, which more generally correspond to the services sectors of the economy, rather in line with the value of 48.6% of employment in the services sectors in Luxembourg in 2000. The ratio of resident to non-resident employment is about 1.42, and the wages of the non-resident workers are about 15% lower than those of the resident workers.

Finally, for the public sector, the deficit is very low (due to a comparable level of tax receipts and expenditures) and the public debt is about 7% of GDP, in line with actual values before the crisis.

4 Shocks to the banking sectors

We now assess the consequences of a variety of changes in the banking sectors. Our first objective is to illustrate the general equilibrium properties of our model. To proceed, we consider a biased growth driven by an increase in the productivity of the banking sector only. Under such circumstances, we expect in general equilibrium that the advantaged sector will attract resources to grow. Hence a combination of macroeconomic growth and reallocation of resources towards the sector fueling this growth. The second objective is to assess the impact of economic policies and exogenous shocks to the banking sector, like decreases in the supply of foreign deposits, increases in the monetary policy rate, increases in the international and domestic banks reserves, and increases in the working capital requirements. The final objective is to assess the robustness of the results to some changes in the structure of the banking sectors. In particular, we assess the consequences of a different bargaining in the labour market between unions and banks, and of a lower share of the banking sector in the economy.

For each shock, we focus first on the effects on a set of key variables at the sectoral level, including wages, employment and total wage bill of resident and non-resident workers, capital, output in the case of the production sectors, and deposits and interest rates for the banking sectors. Then we move at the aggregate level and evaluate the effects on GDP and private demand components (Consumption, Investment, Net exports), government deficit, capital stock and returns on capital, profits, unemployment, wages, employment and total wage bill of resident and non-resident workers, total assets, and TFP.

As common, we focus on the changes in each variable with respect to its starting value, and use +, ++ and +++ to denote an increase in the range of, respectively, 0-0.5%, 0.5-1% or larger than 1%. The symbols -, - -, and - - - have a similar interpretation for negative changes.[8] We present detailed results for the first experiment, while results for the other experiments are contained in a not for publication Appendix.

4.1 General equilibrium properties

We start with the productivity of the banking sector, and more generally of the services sector. This experiment is justified by the uneven distribution of productivity gains across sectors, and fits well the characteristics of an advanced services economy.[9] As changes in the productivity in one sector will affect the other sectors in general equilibrium, this experiment helps understanding the general equilibrium properties of the model.

Interestingly, a positive change in one sector may be detrimental to another sector if resources are displaced. These effects are traditional in any general equilibrium framework fitting full employment. Here, the aggregate effects are uncertain, since more productive capital and labour could lower the required amounts of these factors of production, possibly generating unemployment and a drop in investment in the absence of an increase in aggregate demand. We proceed in two steps, starting with technical progress in the international banking only, before comparing with the situation where productivity arises in the domestic banking sector. We indeed expect different general equilibrium effects as one of the inputs of the international banking sectors is foreign deposits.[10]

[8] More detailed results and findings for other variables are available upon request.

[9] This contrasts with the traditional hypothesis that productivity gains are larger in industry.

[10] We have also considered the effects of higher productivity in both banking sectors. However, since the size of the international

Let us simply consider a permanent increase of 1% in the productivity of the international banks only, whose effects are summarized in Table 1A at the sectoral level, and in Table 1B at the aggregate level.

The increase in productivity would bring to an increase in profits, which is not possible given perfect competition. As it is relatively less costly to produce banking services, resources shift towards this sector. Banks increase their output, therefore hiring more labour and renting more capital, and increasing the demand of international deposits. Hence, there is an increase in the returns on capital, and in the interest rate on international deposits. Concerning wages, the effects of workers' displacement is uncertain. Outside the banking sector, employment decreases, as well as wages. But as a result of bargaining, wages decrease less than expected, and employment decrease more. Thus, there are more workers to be re-employed in the growing sector than under perfect competition on the labour market. Hence, in the banking sectors, the unions are willing to accept an even lower real wage in exchange for a substantial increase in employment.

Therefore, overall in the international banking sector the increase in productivity determines more employment and more total wages, a minor decrease in per capita wages, more capital and a mild increase in the aggregate return on capital, and higher international deposits and interest rate on them.

The increase in the rental and wage bill in the international banking sector requires higher working capital, and hence the demand for credit from domestic banks increases. To match the increased demand, associated with an increase in the related interest rate on domestic deposits, more capital and labour are needed in the domestic banking sector. The former brings the rental cost of capital further up, the latter determines also in this sector a minor decrease in the real wage, accompanied by a more relevant increase in employment and in the total wage bill, for both resident and non resident workers.

In the tradable goods, non tradable goods and distributors sectors, the higher rental rate of capital decreases investment and the capital stock. This in turn lowers the capital per worker and hence labour productivity. There should therefore be a major decrease in the wage, but this effect is attenuated – as already mentioned – by the bargaining between the unions and the firms. Since the decrease in wage is only limited, firms react by shedding employment, with an overall noticeable effect on the total wage bill in all the three sectors. Lower capital and labour lead to a decrease in output, and in turn this brings to lower profits.

Hence, an interesting story emerges. Indeed increases in productivity that are not homogeneous across sectors determine substantial sectoral reallocations of capital and labour, and affect their relative compensation across sectors. However, changes in factor returns in the disadvantaged sector are contrasted, with labour compensation losing less than expected due to bargaining, but labour demand adjusting more sharply.

The overall effects on the economy of higher productivity in the international banking sector are shown in Table 1B. The increase in capital in the two banking sectors more than compensates the decrease in the production sectors, so that at the aggregate level investment and capital increase, as well as the returns on capital. For employment and the total wage bill a different story holds, as the per capita wage mildly decreases as explained above. The decrease in total profits in the production sectors more than offsets the higher wage bill, so that overall private consumption, and assets, decrease. Net exports instead increase, mostly due to a decrease in the amount of imports. Overall, the effects on GDP are mildly positive.

sector is much higher than that of the domestic sector in the calibrated version of the model, the effects are very similar to those reported in the first part of this subsection, and therefore we do not discuss them in detail.

In terms of fiscal balance, the deficit decreases. A look at the separate behaviour of expenses and receipts reveals that the former decrease, mostly due to lower unemployment, and the latter as well, though to a lesser extent. Lower receipts are due to the major decrease in profits and taxes on them, an effect that dominates the higher payments coming from higher rental and wage bills.

Let us now consider the consequences of higher productivity in the domestic banking sector, starting with the effects within this sector. Results are summarized in Tables A1a and A1B. As in the previous case, with higher productivity profits would go up, which is not possible so that the banks should increase capital and labour.

However, there is now no major increase in working capital needs in the other sectors, and so no request for higher "production" in this domestic banking sector. Due to the higher productivity, the banks can keep production fixed or mildly decrease it even if using smaller amounts of capital and labour.

Lower labour demand enters into the bargaining and lowers the total wage bill, which enter into the loss function of the unions that ask for a small increase in the per capita wage as a compensation, also related to the increased labour productivity. Since capital and labour are complement, capital demand also decreases. Thus, overall the effects on the domestic banking sector of an increase in productivity within this sector are rather negative, with both capital, labour and the total wage bill decreasing, for both resident and non resident workers. The key for this result is the lack of more demand for the output of this sector. This also implies that the interest rate (the cost of working capital) decreases a bit.

The lower cost of working capital is however beneficial for the production sectors. In both the traded, non traded and distributors sectors there is an increase in demand for capital and labour, associated with higher returns on capital and wages, and also higher total wages, profits and output.

The effect on the international banking sector are similarly positive, since this sector also uses the working capital, However, overall the effects are rather small since the size of the domestic banking sector is limited.

At the aggregate level, from Table 4B, the effects are quantitatively limited but qualitatively positive, except for a small decrease in employment that is however associated with higher total wages. All the private demand component increase, as well as GDP, and the fiscal deficit is reduced thanks to higher tax receipts on higher profits, and rental and wage bills. Hence, while also in this case there are relevant sectorial differences, higher productivity is overall positive for the economy as a whole.

4.2 Foreign deposits

We now turn to policy simulations and economic shocks affecting the financial cluster. Firstly, a decrease in the supply of foreign deposits can be used to mimic one of the consequences of the recent financial crisis, where many banks and other investors brought large amounts of funds back home.

We consider the consequences of a permanent 1% exogenous decrease in D^*, the foreign deposits used by the international banks. The results are summarized in Tables A2A and A2B.

Starting with the effect in the international banking sector, as a reaction to lower deposits the banks want to decrease also the other inputs, namely, capital and labour. Due to the firms-union bargaining, we end up with a slight increase in real wages accompanied by a substantial decrease in employment. The capital stock

also diminishes substantially, and brings down the cost of capital. Overall the activity of this sector shrinks substantially.

The lower cost of capital is however good news for the tradable, non tradable and distributors sectors, who react by increasing the capital demand, and therefore also the labour demand, due to complementarity across inputs. Hence, wages also increase, though mildly since the unions appreciate the increased labour demand, and the overall total wage bill is higher for both resident and non resident workers. The output of three sectors, and the profits, are higher across the entire simulation period. This outcome would be of course different in the presence of other simultaneous shocks affecting directly these sectors, such as an increase of their financing costs.

The wage and rental bills increase substantially in the traded, non traded and distributors sectors, but not enough to offset the major drop in the international banking sector. This is evident from the aggregate results in Table 5B. Hence, the overall demand for credit, associated with the working capital, shrinks, which means that there is a contraction in the domestic banking sector. Actually, this sector experiences a drop in the demand for both labour and capital, and a small reduction in the activity level, also associated with slightly lower interest rates on deposits.

At the aggregate level, lower interest rates on deposits stimulate consumption even in the presence of a small decrease in the total wage bill (again related to the dominant role of the international banking sector). However, both investment and net exports decrease, as well as Gross Domestic Product. Profits increase, due to the good performance in the sectors that operate under imperfect competition. This increases the tax receipts, but not enough to compensate for the lower receipts associated with lower wage and rental bills. Hence, the deficit deteriorates, which brings in automatic cuts in public expenditures, including productive expenditures that in turn leads to a (limited) reduction in TFP.

To conclude, it is worth mentioning that without the positive reaction of the industrial sectors (that could be also affected by a negative shock related to the event that caused the drop in foreign deposits), the aggregate results would be much worse.

4.3 Monetary policy

An increase in the central bank interest rate permits to assess at a disaggregate sectoral level the effects of a change in monetary policy, enhancing the understanding of the aggregate effects. We consider the effects of a tightening of monetary policy, specifically, a permanent 1% increase in the policy rate. The results are summarized in Tables A3A and A3B.

The higher policy rate translates into a higher interest rate paid on the foreign (non euro area) deposits in the international banking sector. This increases the supply of funds, and therefore also increases the demand for labour and capital. This is associated with an increase in the returns on capital, but with a decrease in the per capita wages since, as explained above, the unions are willing to accept a small increase in the per capita wage in exchange for a major increase in employment, thus maximizing the overall wage bill, for both residents and non residents. Hence, overall the activity of the international banking sector expands substantially.

In principle we should expect that a tightening of monetary policy should translate into lower output and employment, but here there is an additional effect due to the presence of the international banking system. If and only if the country offers a better remuneration to deposits, there is a marked increase in the activity of the international banking system that more than compensates the contraction of the rest of the economy as a result of the large size of this sector. Hence, the outcome of increases in interest rates in small very open economies specialised in financial transformation can be very specific.

The three production sectors of the economy, on the other hand, suffer. This is because higher interest rates and higher demand for capital in the investment bank sector make investment more costly, and hence the capital level shrinks. This causes a reduction in labour demand as well, accompanied by lower total wages for both residents and non resident workers. Overall, the output in the all three sectors shrinks substantially. This is a feature to be taken into consideration in the policy debate in highly specialized economies, in the sense that under certain circumstances the development of the advantaged sector can be detrimental to the other sectors.

The domestic banks face a lower demand for working capital by the production sectors, but a much higher one from the international banking sector. At the same time, higher interest rates make it more convenient to postpone consumption and increase savings, so that the supply of deposits increases, so much so that the increased demand can be matched even in the presence of a lower interest rate on deposits paid by the commercial banks. The capital stock and employment also increase in this sector, as well as the rental and wage bills.

At the aggregate level, we get a mixed picture, see Table A3B. Total private consumption, as said, decreases but investment and net exports increase, the latter due mostly to lower imports since production in the intermediate sectors and consumption shrink, and higher export of financial services. Overall the effects on GDP are positive. Both the capital stock and employment increase, as well as the total capital and wage bills. However, profits are reduced, since the sectors in imperfect competition shrink. The effects on the fiscal balance are positive, due to lower expenditures for unemployment subsidies and higher receipts on capital and labour.

The aggregate results we have obtained are fairly different from the standard text-book analysis, which would suggest lower aggregate investment and GDP as a consequence of a tighter monetary policy. The difference is due to the dominant role in the small open economy of the international banking sector that actually benefits from the higher policy rates. The results for the more traditional production sectors are indeed in line with standard economic theory.

4.4 Banks reserves

We now consider the consequences of an increase in the bank reserves, which can originate either by regulation or by the desire of the banks to be better prepared in case of emergency situations. We start with a 1% point permanent increase in the reserves of the international banks, and then move to the same type of shock for the domestic banks. The results are presented, respectively, in Tables A4A, A4B and A5A, A5B.

Higher reserves for the international banks is equivalent to a drop in available funds to be used as input

in the "production" process. Since the production inputs are complementary, the banks also decrease their demand of labour and capital, with subsequent negative effects on the returns on capital and on the total wage bill.

The lower capital cost is good news for the production sectors, and they all react by increasing the demand of capital, and as a consequence of labour. Hence, these sectors expand while the international banking sector shrinks.

The domestic banks are mostly affected through the changes in the working capital, that are positive for the production sectors, negative for the international banks, and overall negative. Lower working capital needs therefore generate a decrease in the interest rate on deposits, but also in the demand for labour and capital, with negative consequences similar to those in the international banking sector, though more limited.

At the aggregate level, see Table A4B, the higher returns on capital have a negative effect on investment, but the lower interest rates on deposits stimulate consumption, notwithstanding a decrease in the total wage bill and partly also thanks to higher profits (that we remind are redistributed to the consumers). The overall effects are however quite negative, with higher unemployment and deficit, and lower GDP.

The effects of higher reserves for the domestic banks are also negative, but the transmission mechanism is rather different, as we will now see. Starting from the domestic bank sector, Table A5A shows, at first sight surprisingly, good results. Higher reserves means lower funds available for lending. However, the demand of working capital by the production sectors and the international banks is basically unchanged. Hence, the interest rate paid for the working capital increases substantially, as well as paid by the banks on deposits, inducing consumers to increase the deposits they offer in order to match the increased needs. The higher level of this "production" input requires to increase also the use of capital and labour, with positive effects on employment and the total wage bill for both residents and non resident workers.

For the other sectors, there is no major credit crunch but a substantial increase in the financing costs, that brings both the international banks and the producers in the traded, non traded and distribution sectors to shrink both capital, and labour, and production. Hence, the results for these sectors in Table 8A are virtually all minuses.

At the aggregate level, the positive effects on the commercial banks are nearly invisible, due to the overall small size of this sector. The negative effects for the other sectors dominate, with negative consequences on virtually all the aggregate variables reported in Table A5B.

4.5 Working capital requirements

The last experiment we consider is a 1% permanent increase in the working capital, which mimics the general increase in the liquidity needs of the firms experienced during the crisis. The results are reported in Tables A6A and A6B.

Starting this time from the production sectors, we see from Table 9A that the effects are very similar across the traded, non traded and distribution sectors, and all negative. The firms in these sectors reduce the demand for capital and labour, and in turn this has negative effects on the returns on capital and on real wages, and of course on output.

The results for the international bank sector are very similar to those mentioned above, with a generalized deterioration in all the variables.

The effects for the domestic banks are instead positive, since they can charge higher interests on the loans to the firms, and can also pay higher interests on the deposits from consumers in order to match the increased need of working capital. This also leads to higher demand for labour and capital, and to an increase in the total wages for both resident and non resident workers.

At the aggregate level, see Table A6B, the negative consequences in the large international banking and production sectors dominate, determining a generalized and prolonged deterioration in the economic conditions. GDP and all the demand components decrease. There is only a very small positive effect on employment after the second year after the shock, but the total wage bill diminishes for both the residents and the non resident workers. The fiscal position deteriorates substantially, due to lower tax receipts on both profits and capital and income.

4.6 Robustness analysis

In this section we assess how robust are the results we have obtained to some changes in the structure of the banking sector. First, we consider the monopoly union case, where unions act as a monopolist in the labour market and maximize the total wage bill, taking the labour demand of the firms into account. This corresponds to increasing to unity the bargaining power of the unions in the wage negotiations with the banks. Second, we consider the opposite case, where the union power decreases. Finally, we consider a different calibration of the model, such that the value added of the banking sector in steady state decreases from about 53% to about 39%. We have repeated all the policy experiments discussed in this section for each of the three different scenarios, but here for simplicity we will focus on the effects of an increase in the productivity of the international banking sector, the first experiment we have considered. The results are fairly representative of the consequences that the different scenarios have on the outcome of the other policy changes.

Starting with the case of stronger union power in the banking sector, the results are reported in Tables A7a at the disaggregate sectorial level, and A7b at the aggregate economy level. Comparing Tables A7a and 1a, we see hardly any differences. However, a look at the numbers underlying the plus and minuses in the tables (available upon request), reveals that there is a slightly lower decrease in the real wages in the international banking sector, as a consequence of the stronger union power, and a slightly lower increase in employment, coming from the reaction of the banks to the slightly worse conditions for them in the labour market in terms of higher wages. At the aggregate level, a comparison of Tables A7b and 1b reveals a similar pattern. In particular, there is now an increase in real wages for both resident and non resident workers already 3-4 years after the shock (and a smaller decrease before then), while in the original formulation wages only increased after 10 years. The counterpart of this positive effect is a smaller increase in employment, in particular in the medium and long term (after 10 years). The overall effects of the higher productivity in the banking sector remain however positive, with higher GDP and investment, notwithstanding the negative displacement effects in the other (tradable and non tradable) sectors of the economy, where employment and wages decrease, as

in the baseline case, causing a slight decrease in aggregate consumption.

The effects of lower union power are symmetric, and more evident at the aggregate level. A comparison of Tables A8b and 1b reveals that wages, both per capita and as total wage bill, are now slightly lower, and this determines slight more employment (this effect is only visible from the detailed results, which are available upon request).

Finally, the results for the case of a lower share of the banking sector in the value added are reported in Tables A9a and A9b. A lower share of the banking sector implies that the positive effects in this sector coming from higher productivity are lower, but the negative effects on the other sectors are also lower, so that the aggregate effects are not obvious. A comparison of Tables 1b and A9b (and also 1a and A9a) suggests that the effects are fairly similar in the two cases. An analysis of the actual figures confirms this finding, revealing only a slight increase in aggregate GDP, investment and employment in the presence of a smaller banking sector, but accompanied by slightly lower per capita wages and consumption.

Overall, this robustness analysis suggests that the qualitative results we have obtained as an outcome of the policy experiments are fairly robust to modifications in the size of the banking sector, and to the working of the labour market in this important sector of the economy. Hence, our findings are of more general relevance for small open economies, beyond the specific calibration chosen here.

5 Conclusions

In this paper we have developed a structural macroeconometric model of the NOEM-DSGE type, characterized by the presence of the banking and distribution sectors, two key sectors for a small open economy and to understand the consequences of the recent financial crises and some related policy responses.

The model is characterized by a careful theory based specification of the economy, which is represented by households, government, firms and unions, which interact in the product, labour, financial, banking, and distribution markets.

As an illustration, the model is calibrated to mimic the features of Luxembourg, where the financial sector plays a key role, and it is used to provide useful qualitative insights on the expected consequences of a variety of changes in economic policy. It is also relevant to assess the impact and propagation effects of several types of economic shocks. Specifically, we have used the calibrated model to assess the consequences of a variety of changes in the banking sector, in which the small open economy is specialized. We have considered, in turn, increases in the productivity of the banking sector, decreases in the supply of foreign deposits, increases in the monetary policy rate, increases in the international and domestic banks reserves, and increases in the working capital requirements.

To conclude, the set of specific features of the economy modelled here, such as a dual labour market and the presence of a sizable financial sector, is a structure that can be of general interest for modeling small open economies.

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6 Appendix: functional forms

In the following we specialize the analysis of the production sector and labour market to the case of a CES production function. For the sake of clarity, we do not distinguish between tradable and non-tradable goods in the intermediate goods sector, but the same production function is assumed in both production processes:

$$y = A\left[\alpha k^{\lambda} + (1-\alpha)(\Lambda h)^{\lambda}\right]^{\frac{1}{\lambda}}, \tag{119}$$

$$h = \left[\sum_{z=1}^{2} \varkappa_z (a_z h_z)^{\kappa}\right]^{\frac{1}{\kappa}}, \tag{120}$$

with $\varkappa_2 = 1 - \varkappa_1$. Note that Λ represents a labour-augmenting productivity parameter. We allow for a (purely external) effect of the stock of public infrastructure ($INFR_t$) on the Total Factor Productivity, A. In particular, we model A as:

$$A = (INFR_t)^{\varpi} \cdot EXOG \cdot PROD, \tag{121}$$

where $0 < \varpi < 1$, $EXOG$ represents exogenous technical progress growing at a constant rate γ, and $PROD$ the stochastic, persistent, but stationary component that drives the real business cycle. We assume that:

$$\log(PROD_t) = \rho \log(PROD_{t-1}) + \varepsilon_{at}. \tag{122}$$

where $\rho \in (0,1)$ measures the persistence of productivity.

It follows that the first order conditions of the firm can be written as:

$$\frac{p}{\mu}(\Lambda A)^{\lambda}(1-\alpha)\left(\frac{h}{y}\right)^{\lambda-1} \varkappa_z a_z^{\kappa}\left(\frac{h_z}{h}\right)^{\kappa-1} = (1+\tilde{\tau}_L)\left(1+\psi_L i_t^W\right) w_z, \tag{123}$$

$$\frac{p}{\mu} A^{\lambda} \alpha \left(\frac{k}{y}\right)^{\lambda-1} = \left(1+\psi_K i_t^W\right) r. \tag{124}$$

This implies that:

$$\epsilon_z = \left[\left(\frac{1-\mu\lambda}{\mu}\frac{\partial y}{\partial h}\frac{h}{y} + \lambda - \kappa\right)\frac{\partial h}{\partial h_z}\frac{h_z}{h} + \kappa - 1\right]^{-1}. \tag{125}$$

The production function for the transport services used in the importing sector is similar, but not identical:

$$y^M = \pi_2\left[\alpha\left(k^M\right)^{\lambda} + (1-\alpha)\left(\Lambda h^M\right)^{\lambda}\right]^{\frac{1}{\lambda}}, \tag{126}$$

where π_2 is a constant productivity parameter. Also the detivation of the elasticity of labor demand is sligtly different:

$$\epsilon_z^M = \left(\begin{array}{c} \left\{\left[\frac{1-\mu}{\mu}\frac{p^M}{p^M - \mu(1+t^M)\frac{p_M^*}{\pi_1}} - \lambda + 1\right]\frac{h^M}{y^M}\frac{\partial y^M}{\partial h^M} + \lambda - \kappa\right\} \times \\ \frac{\partial h^M}{\partial h_z^M}\frac{h_z^M}{h^M} + \kappa - 1 \end{array}\right)^{-1}. \tag{127}$$

Table 1a. Disaggregate effects of a 1% increase in FB productivity

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Interest on foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Domestic Bank							
Total demand deposits	+	+	+	+	+	+	++
Interest on demand deposits	+	+	+	+	+	+	+
Net interest rate on working capital	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+	+	+	+	+	+	++
Total wages, non resident	+	+	+	+	+	+	++
Value added (GDP %)	+	+	+	+	+	+	+
Non traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Distributors							
Output	---	---	---	---	---	---	---
Imported foreign varieties	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table 1b. Aggregate effects of a 1% increase in FB productivity

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	+	+	+	+	+	+	+
Consumption	-	-	-	-	-	-	-
Investment	+	+	+	+	+	+	+
Net exports	---	+	+	+	++	++	++
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	+	+
Returns on capital	+	+	+	+	+	+	+
Profits	---	---	---	---	---	---	---
Unemployment	---	---	---	---	---	---	---
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+	+	+	+	+	++	++
Total wages, non resident	+	+	+	+	+	+	++
Total assets	-	-	-	-	-	-	-
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

NOT FOR PUBLICATION TABLE APPENDIX

Table A1a. Disaggregate effects of a 1% increase in CB productivity

	Horizon in years after the shock						
Sector / Variable	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+	+	+	+	+	+	+
Interest on foreign demand deposits	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	+	+	+	+	+	+	+
Employment, non resident	+	+	+	+	+	+	+
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+	+	+	+	+	+	+
Total wages, non resident	+	+	+	+	+	+	+
Value added (GDP %)	+	+	+	+	+	+	+
Domestic Bank							
Total demand deposits	-	-	-	-	-	-	-
Interest on demand deposits	-	-	-	-	-	-	-
Net interest rate on working capital	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Non traded							
Output	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	+	+	+	+	+	+	+
Employment, non resident	+	+	+	+	+	+	+
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+	+	+	+	+	+	+
Total wages, non resident	+	+	+	+	+	+	+
Profits	+	+	+	+	+	+	+
Value added (GDP %)	+	+	+	+	+	+	+
Traded							
Output	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	+	+	+	+	+	+	+
Employment, non resident	+	+	+	+	+	+	+
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+	+	+	+	+	+	+
Total wages, non resident	+	+	+	+	+	+	+
Profits	+	+	+	+	+	+	+
Value added (GDP %)	+	+	+	+	+	+	+
Distributors							
Output	+	+	+	+	+	+	+
Imported foreign varieties	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	+	+	+	+	+	+	+
Employment, non resident	+	+	+	+	+	+	+
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+	+	+	+	+	+	+
Total wages, non resident	+	+	+	+	+	+	+
Profits	+	+	+	+	+	+	+
Value added (GDP %)	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A1b. Aggregate effects of a 1% increase in CB productivity

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	+	+	+	+	+	+	+
Consumption	+	+	+	+	+	+	+
Investment	+	+	+	+	+	+	+
Net exports	--	+	+	+	+	+	+
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	+	+
Returns on capital	+	+	+	+	+	+	+
Profits	+	+	+	+	+	+	+
Unemployment	-	+	+	+	+	+	+
Employment, resident	+	-	-	-	-	-	-
Employment, non resident	+	+	+	-	-	-	-
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+	+	+	+	+	+	+
Total wages, non resident	+	+	+	+	+	+	+
Total assets	-	-	-	-	-	-	-
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A2a. Disaggregate effects of a 1% decrease in D*

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	---	---	---	---	---	---	---
Interest on foreign demand deposits	-	-	-	-	-	-	-
Capital stock	--	--	--	--	--	--	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Domestic Bank							
Total demand deposits	-	-	-	-	-	-	-
Interest on demand deposits	-	-	-	-	-	-	-
Net interest rate on working capital	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Non traded							
Output	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Profits	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Traded							
Output	++	++	++	++	++	++	++
Capital stock	+++	+++	+++	+++	+++	++	++
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Profits	++	++	++	++	++	++	++
Value added (GDP %)	++	++	++	++	++	++	++
Distributors							
Output	++	++	++	++	++	++	++
Imported foreign varieties	++	++	++	++	++	++	++
Capital stock	+++	+++	+++	+++	+++	++	++
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Profits	++	++	++	++	++	++	++
Value added (GDP %)	++	++	++	++	++	++	++

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A2b. Aggregate effects of a 1% decrease in D*

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	-	-	-	-	-	-	-
Consumption	+	+	+	+	+	+	+
Investment	-	-	-	-	-	-	-
Net exports	+++	-	-	-	-	-	-
Government deficit	+++	+++	+++	+++	+++	+++	+++
Capital stock	-	-	-	-	-	-	-
Returns on capital	-	-	-	-	-	-	-
Profits	++	++	++	++	++	++	++
Unemployment	+++	+++	+++	+++	+++	+++	+++
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Total assets	+	+	+	+	+	+	+
Total Factor Productivity	-	-	-	-	-	-	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A3a. Disaggregate effects of a 1% increase in interest rate

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Interest on foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)							
Domestic Bank							
Total demand deposits	++	++	++	++	++	++	++
Interest on demand deposits	-	-	-	+	+	+	+
Net interest rate on working capital	-	-	-	-	-	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Value added (GDP %)							
Non traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)							
Traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)							
Distributors							
Output	---	---	---	---	---	---	---
Imported foreign varieties	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits							
Value added (GDP %)	---	---	---	---	---	---	---

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A3b. Aggregate effects of a 1% increase in interest rate

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	+	+	+	+	+	+	+
Consumption	--	--	--	--	--	--	--
Investment	+	+	+	+	+	+	+
Net exports	---	+++	+++	+++	+++	+++	+++
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	+	+
Returns on capital	++	++	++	++	++	+	+
Profits	---	---	---	---	---	---	---
Unemployment	---	---	---	---	---	---	---
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Total assets	+	+	+	+	+	+	++
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A4a. Disaggregate effects of a 1% point increase in FB reserves

	Horizon in years after the shock						
Sector / Variable	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	---	---	---	---	---	---	---
Interest on foreign demand deposits	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	++	++	++	++	++	+	+
Wages, non resident	++	++	++	++	++	+	+
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Domestic Bank							
Total demand deposits	---	---	---	---	---	---	---
Interest on demand deposits	-	-	-	-	-	-	-
Net interest rate on working capital	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	--
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	++	++	++	++	++	+	+
Wages, non resident	++	++	++	++	++	+	+
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Non traded							
Output	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	++	++	++	++	++	+	+
Wages, non resident	++	++	++	++	++	+	+
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Profits	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Traded							
Output	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	++	++	++	++	++	+	+
Wages, non resident	++	++	++	++	++	+	+
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Profits	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Distributors							
Output	+++	+++	+++	+++	+++	+++	+++
Imported foreign varieties	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	++	++	++	++	++	+	+
Wages, non resident	++	++	++	++	++	+	+
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Profits	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A4b. Aggregate effects of a 1% point increase in FB reserves

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	-	-	-	-	-	-	-
Consumption	++	++	++	++	++	++	++
Investment	--	--	--	--	--	--	---
Net exports	+++	---	---	---	---	---	---
Government deficit	+++	+++	+++	+++	+++	+++	+++
Capital stock	-	-	-	-	-	-	--
Returns on capital	---	---	---	--	--	--	--
Profits	+++	+++	+++	+++	+++	+++	+++
Unemployment	+++	+++	+++	+++	+++	+++	+++
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	+	+	+	+	+	+	+
Wages, non resident	+	+	+	+	+	+	+
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Total assets	+	+	+	+	+	+	++
Total Factor Productivity	-	-	-	-	-	-	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A5a. Disaggregate effects of a 1% point increase in CB reserves

	Horizon in years after the shock						
Sector / Variable	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	-	-	-	-	-	-	-
Interest on foreign demand deposits	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Domestic Bank							
Total demand deposits	++	++	++	++	++	++	++
Interest on demand deposits	+++	+++	+++	+++	+++	+++	+++
Net interest rate on working capital	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Non traded							
Output	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Traded							
Output	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Distributors							
Output	-	-	-	-	-	-	-
Imported foreign varieties	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	+	+	+	+	+	+	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A5b. Aggregate effects of a 1% point increase in CB reserves

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	-	-	-	-	-	-	-
Consumption	-	-	-	-	-	-	-
Investment	-	-	-	-	-	-	-
Net exports	+++	-	-	-	-	-	-
Government deficit	+++	+++	+++	+++	+++	+++	+++
Capital stock	-	-	-	-	-	-	-
Returns on capital	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Unemployment	+	+	+	+	+	+	+
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Total assets	+	+	+	+	+	+	+
Total Factor Productivity	-	-	-	-	-	-	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A6a. Disaggregate effects of a 1% increase in working capital

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	-	-	-	-	-	-	-
Interest on foreign demand deposits	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Domestic Bank							
Total demand deposits	++	++	++	++	++	++	++
Interest on demand deposits	++	++	++	++	++	++	++
Net interest rate on working capital	+	+	+	+	+	+	+
Capital stock	++	++	++	++	++	++	++
Employment, resident	++	++	++	++	++	++	+++
Employment, non resident	++	++	++	++	++	++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Value added (GDP %)	++	++	++	++	++	++	++
Non traded							
Output	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Traded							
Output	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-
Distributors							
Output	-	-	-	-	-	-	-
Imported foreign varieties	-	-	-	-	-	-	-
Capital stock	-	-	-	-	-	-	-
Employment, resident	-	-	-	-	-	-	-
Employment, non resident	-	-	-	-	-	-	-
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Value added (GDP %)	-	-	-	-	-	-	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A6b. Aggregate effects of a 1% increase in working capital

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	-	-	-	-	-	-	-
Consumption	-	-	-	-	-	-	-
Investment	-	-	-	-	-	-	-
Net exports	++	-	-	-	-	-	-
Government deficit	+++	+++	+++	+++	+++	+++	+++
Capital stock	-	-	-	-	-	-	-
Returns on capital	-	-	-	-	-	-	-
Profits	-	-	-	-	-	-	-
Unemployment	+	+	+	+	-	-	-
Employment, resident	-	-	-	-	+	+	+
Employment, non resident	-	-	-	-	-	+	+
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	-	-	-	-	-	-	-
Total wages, non resident	-	-	-	-	-	-	-
Total assets	+	+	+	+	+	+	+
Total Factor Productivity	-	-	-	-	-	-	-

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A7a. Disaggregate effects of a 1% increase in FB productivity - Different bargaining

	Horizon in years after the shock						
Sector / Variable	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Interest on foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Domestic Bank							
Total demand deposits	+	+	+	+	+	+	++
Interest on demand deposits	+	+	+	+	+	+	+
Net interest rate on working capital	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+	+	+	+	+	++	++
Total wages, non resident	+	+	+	+	+	++	++
Value added (GDP %)	+	+	+	+	+	+	+
Non traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Distributors							
Output	---	---	---	---	---	---	---
Imported foreign varieties	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A7b. Aggregate effects of a 1% increase in FB productivity - different bargaining

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	-	+	+	+	+	+	+
Consumption	-	-	-	-	-	-	-
Investment	+	+	+	+	+	+	+
Net exports	---	+	+	+	+	+	++
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	+	+
Returns on capital	+	+	+	+	+	+	+
Profits	---	---	---	---	---	---	---
Unemployment	---	---	---	---	---	---	---
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	+
Wages, non resident	-	-	-	-	-	-	+
Total wages, resident	+	+	+	+	+	++	++
Total wages, non resident	+	+	+	+	+	++	++
Total assets	-	-	-	-	-	-	-
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A8a. Disaggregate effects of a 1% increase in FB productivity - Lower union power

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Interest on foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
Value added (GDP %)	+++	+++	+++	+++	+++	+++	+++
Domestic Bank							
Total demand deposits	+	+	+	+	+	+	++
Interest on demand deposits	+	+	+	+	+	+	+
Net interest rate on working capital	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+	+	+	+	+	+	++
Total wages, non resident	+	+	+	+	+	+	++
Value added (GDP %)	+	+	+	+	+	+	+
Non traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Distributors							
Output	---	---	---	---	---	---	---
Imported foreign varieties	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A8b. Aggregate effects of a 1% increase in FB productivity - lower union power

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	+	+	+	+	+	+	+
Consumption	-	-	-	-	-	-	-
Investment	+	+	+	+	+	+	+
Net exports	---	++	++	++	++	++	++
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	+	+
Returns on capital	+	+	+	+	+	+	+
Profits	---	---	---	---	---	---	---
Unemployment	---	---	---	---	---	---	---
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+	+	+	+	+	+	++
Total wages, non resident	+	+	+	+	+	+	++
Total assets	-	-	-	-	-	-	-
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A9a. Disaggregate effects of a 1% increase in FB productivity - Lower share of banks in VA

Sector / Variable	Horizon in years after the shock						
	1y	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
International Bank							
Foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Interest on foreign demand deposits	+++	+++	+++	+++	+++	+++	+++
Capital stock	+++	+++	+++	+++	+++	+++	+++
Employment, resident	+++	+++	+++	+++	+++	+++	+++
Employment, non resident	+++	+++	+++	+++	+++	+++	+++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	+++	+++	+++	+++	+++	+++	+++
Total wages, non resident	+++	+++	+++	+++	+++	+++	+++
	+++	+++	+++	+++	+++	+++	+++
Domestic Bank							
Total demand deposits	++	++	++	++	++	++	++
Interest on demand deposits	+	+	+	+	+	+	+
Net interest rate on working capital	+	+	+	+	+	+	+
Capital stock	+	+	+	+	+	+	+
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Value added (GDP %)	++	++	++	++	++	++	++
Non traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Traded							
Output	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---
Distributors							
Output	---	---	---	---	---	---	---
Imported foreign varieties	---	---	---	---	---	---	---
Capital stock	---	---	---	---	---	---	---
Employment, resident	---	---	---	---	---	---	---
Employment, non resident	---	---	---	---	---	---	---
Wages, resident	-	-	-	-	-	-	-
Wages, non resident	-	-	-	-	-	-	-
Total wages, resident	---	---	---	---	---	---	---
Total wages, non resident	---	---	---	---	---	---	---
Profits	---	---	---	---	---	---	---
Value added (GDP %)	---	---	---	---	---	---	---

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.

Table A9b. Aggregate effects of a 1% increase in FB productivity - lower share of banks in VA

	Horizon in years after the shock						
Aggregate	*1y*	*2y*	*3y*	*4y*	*5y*	*10y*	*20y*
GDP	+	+	+	+	+	+	+
Consumption	-	-	-	-	-	-	-
Investment	+	+	+	+	++	++	++
Net exports	++	++	++	++	++	++	++
Government deficit	---	---	---	---	---	---	---
Capital stock	+	+	+	+	+	++	++
Returns on capital	++	+	+	+	+	+	+
Profits	---	---	---	---	---	---	---
Unemployment	---	---	---	---	---	---	---
Employment, resident	++	++	++	++	++	++	++
Employment, non resident	++	++	++	++	++	++	++
Wages, resident	-	-	-	-	-	+	+
Wages, non resident	-	-	-	-	-	+	+
Total wages, resident	++	++	++	++	++	++	++
Total wages, non resident	++	++	++	++	++	++	++
Total assets	-	-	-	-	-	-	-
Total Factor Productivity	+	+	+	+	+	+	+

Note: +, ++, and +++ indicate, respectively, an increase in the range 0-0.5%, 0.5-1% or larger than 1% with respect to the initial value. -, - -, and - - - indicate, respectively, a decrease in the range -0.5 - 0%, -1 -0.5% or smaller than -1% with respect to the initial value.